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EDITORIAL

HEAT TREATING—THE NEGLECTED ECONOMIC GIANT

In recent months we have had frequent calls upon us to provide facts and figures—statistics about the heat treating industry. And we have found to our despair that apparently no one (as far as we can determine) gathers any data about who does what, or what is used, or how much is spent for equipment and supplies, or what wage rates are, etc., etc.

Even Uncle Sam, the perennial fact finder and survey taker, coudn't tell us one important fact concerning the above categories.

The trade association of the furnace manufacturers (Industrial Heating Equipment Association) does compile monthly sales figures which, of course, indicate plainly but indirectly the ever-expanding physical volume of heat treating being performed or purchased by industry. In dollars, furnace sales jumped from about 45 million in 1954 to 110 million in 1956. This is *big* business.

It follows, therefore, that everything connected with heat treating —the oils, the fuels, the instruments for control, testing, and inspection; all these and many others are being consumed by a growing giant—a market and an activity neglected by the statisticians and other fact finders. (Tip to Sales Managers and Market Experts—Turn your research departments loose on the Heat Treating Industry.)

We are attempting to enlist Government aid and other information sources in an effort to pinpoint not only *where* heat treating is done, but *what* the industry uses, and how many dollars are involved in performing these vital operations. Of one thing we are sure—the results (if obtainable) will be nothing less than startling.

C. E. Herington

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HARDNESS AND ITS MEASUREMENT

By **Vincent E. Lysaght,** *General Sales Manager*
American Chain & Cable Company, Inc.
Bridgeport, Conn.

HARDNESS, in the broadest sense, as applied to minerals is the cohesion of particles on the surface of a body as determined by its capacity to scratch another, or itself be scratched. As applied to water, it is the peculiar quality provided by the liquid containing certain dissolved solids. Such water interferes with the action of soap by forming with it a precipitate or curd, and also causes incrustations in pipes and boilers, etc.

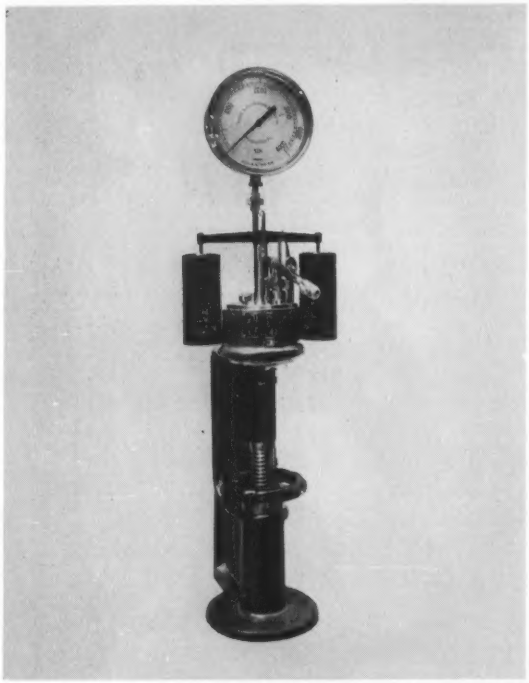


Fig. 1—The Brinell Hardness Tester generally consists of a hand-operated hydraulic press which is designed to force an indenter into the specimen. Hardness values or numbers are taken directly from a table. *Photo courtesy of Tinius Olsen Testing Machine Company.*

Depending on your chosen occupation or field of endeavor, you may still have another definition of hardness as neither statute law nor the laws of physics have been able to clearly define it. However, usage and convenience have suggested and brought about an accepted general meaning of the term which has been used in the broad field of metallurgy.

Definitions

In metallurgy then, it is that resistance to indentation of a given material, compared to such resistance offered by other materials. The limited meaning can therefore be condensed into the accepted phrase "indentation hardness"; where the word "hardness" alone is used in metallurgy, the modifying word "indentation" is generally implied. Unlike other physical conditions such as temperature, pressure, humidity, electrical resistance, etc., hardness has no basic reference standard.

Hardness then, as applied to metals, has been the subject of much discussion in the technical press and among physicists, metallurgists and engineers. It has been given many popular and technical definitions. To digress for a moment, hard or hardness in popular disguise can be defined as strong; mighty; vigorous; forcible; stout; puissant; hefty; rugged; hale; sturdy; doughty; hardy; hard as nails; robust; beefy; brawny; wiry; etc. Also, not easily penetrated or separated into parts; not easily yielding to pressure; firm; solid; and compact. Perhaps you can add many more popular and/or technical definitions.

Dr. L. B. Tuckerman of the National Bureau of Standards represented hardness as "a hazily conceived conglomeration or aggregate of properties of a material more or less related to each other." Compare this with the commonly accepted idea of hardness in the metal-working industry as "resistance to permanent



Fig. 2—Operator is testing a work piece on the Rockwell Hardness Tester, Model 3-JR. These testers, customarily used for most production testing applications, are manufactured in four basic sizes and are similar in appearance from a front view. The vertical working range, however, varies on all four models. *Photo courtesy of Wilson Mechanical Instrument Division, American Chain & Cable Company, Inc.*

indentation". Reference to Dr. Tuckerman's definition is not intended to induce confusion, but rather to show the complex nature of hardness, and to point out that hardness results from numerous properties which may vary independently from one another. This accounts for the lack of a definite meaning of the term "hardness" and for the many widespread definitions and methods of testing it.

Hardness tests have tremendous applications in the metal-working industry, but in the final analysis the test is generally conducted to determine the suitability of a material to fulfill a certain purpose. Grading metals according to hardness, checking the uniformity of metals according to hardness, relating hardness to some other physical property all have the same purpose. However, is the material suitable for the purpose intended is the main question.

As stated before, much has been written by engineers and scholars who know a great deal about the theoretical aspects of hardness testing. There have been many attempts to correlate hardness with other properties, even to the extent of suggesting chemical composition from hardness figures.

Although theory may still be a little obscure, there is no doubt that hardness tests can tell us quite a lot. It is perhaps one of the most widely used methods of non-destructive testing. Its popularity can be attributed in a large measure to its simplicity, cheapness, and speed; coupled with the fact that when other essential factors are known, it can answer some very important questions in a reliable manner. It can, for example, assess the quality of heat treatment and the strength of materials.

In today's "automation age" hardness testing is now considered by many experts as a "must" in practically all manufacturing operations and as a necessary tool or process in the inspection of heat-treated metal parts.

Significance of Hardness Testing

It might be well at this time to consider the significance of hardness testing and to evaluate its scope of application. Steel is said to be brought to its best performance level for a particular application through proper heat treatment. On the other hand, sheet metal is usually brought to proper condition by cold work. Sometimes, a combination of both is used. Such treatments result in a change of hardness. Once the proper limits of hardness are established, it is possible to use the hardness test for inspection and control purposes.

The tensile test, in many cases, is used as a criterion of proper quality for best performance; for example, in forgings, cast iron, low alloy steel, and annealed carbon and alloy steels. For such materials there is a satisfactory relationship between the hardness test and the tensile test. In ferrous materials, the hardness *vs.* tenstile relationship may be determined within a possible error of plus or minus 10 per cent.

If the hardness test is extended beyond the foregoing general uses, great care must be used and many factors taken into consideration in the use of the test. Under certain prescribed conditions, the field of hardness testing may be extended to control machinability, toughness, wear resistance, fatigue strength, etc. Considerable work has been done in at attempt to correlate hardness with machinability.

For any specific operation, as for example rough turning, the hardness test may be used as an index for any one steel, but beyond that it is not advisable to rely upon it too heavily. A new approach to this problem has been made in conjunction with microhardness and use of Meyer's analysis.



Fig. 3—With this Fully Automatic Rockwell Hardness Tester, it is possible to classify up to 1000 Rockwell tests per hour on large-scale production runs. The unit is equipped with a Syntron vibratory hopper for automatic loading of work pieces which are then automatically sorted into three classications—too soft, too hard or correct. *Photo courtesy of Wilson Mechanical Instrument Division, American Chain & Cable Company, Inc.*

Wear resistance is generally examined by some form of wear test, which usually consists of a rotating disc against the surface of which the test piece is pressed under set pressures. The loss of weight of the test piece in a given length of time is an index to wear resistance. Hardness tests do not provide a reliable index for the evaluation of wear except where the

results are compared for metals of the same composition. Under such conditions, the greater the hardness, the more resistant is the metal to wear. The same conditions prevail in the relation between hardness and toughness. A separate relationship must be determined for each metal. It might be added, however, that instruments designed to measure toughness indicate that toughness increases as hardness decreases.

A fairly constant relationship exists between hardness and fatigue strength provided the structure and previous treatment of the steel are controlled. Surface finish, homogeneity of structure and other factors so influence this relationship that it is advisable not to place too much reliability on such curves, unless they have been checked.



Fig. 4—Operator is testing a small work piece on the Rockwell Superficial Hardness Tester, Model 1-JS. Generally, this unit is utilized for the testing of sheet metal and small nitrided or carburized items. ***Photo courtesy of Wilson Mechanical Instrument Division, American Chain & Cable Company, Inc.***

One further use of the hardness test should be mentioned. It is often used in conjunction with the microscope to correlate metal structure with hardness. It provides a clue to help the metallographer interpret results, so that a clearer picture is obtained with the microscope alone.

In any consideration of the use of hardness tests it must be kept in mind that different companies utilize hardness testing for various reasons. Therefore, what may suffice for one manufacturer, such as hardness tolerance or limits, speed of test and depth of penetration, may not be satisfactory or practical for another. Some use the hardness test to check adherence to specifications, others for process control. Some are interested in hardness to the extent that there is a reliable correlation with tensile values while others want to predict fabricating properties. Many use the hardness test for quality control and others use for it for determining the hardness of a material as related to fundamental properties of the material.

The commonly used testing machines for determining resistance to permanent indentation are the Brinell, Rockwell and Diamond Pyramid hardness testers. They are commonly known as indentation hardness units.

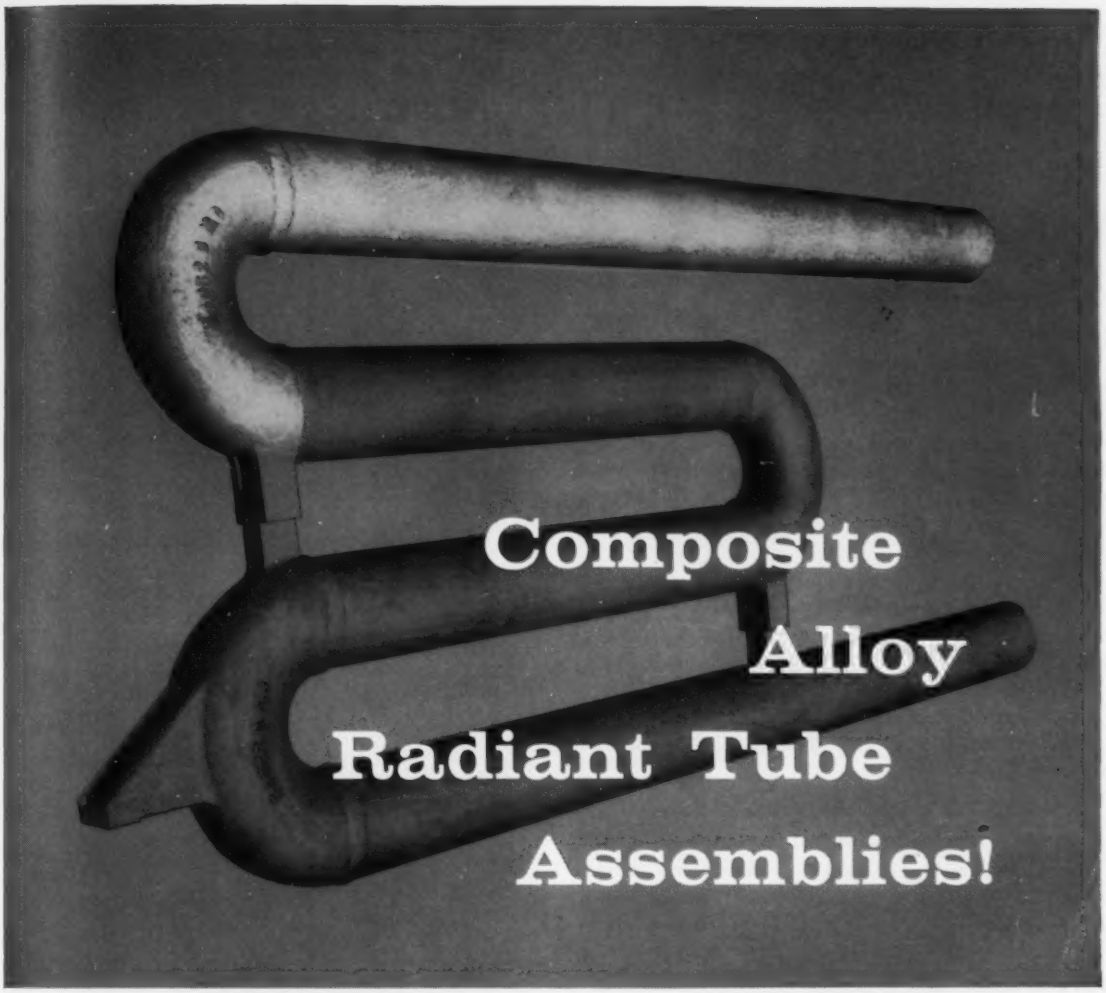
The Brinell method was introduced in 1900 by Dr. J. A. Brinell. The hardness number is the ratio of applied load in kilograms to the surface area of the indentation. This tester, Fig. 1, generally consists of a hand-operated hydraulic press designed to force an indenter into the specimen. The test is made with a 10 mm. diamond ball under a load of 3000 kg. for ferrous metals and a load of 500 kg. for nonferrous metals. This load is generally applied for a period of 30 seconds. Upon removing the load, the diameter of the impression is measured with a microcsope containing a graduated scale usually to 0.1 mm. The hardness number may be taken directly from a table.

The Rockwell tester, Fig. 2, was introduced in 1921 by S. P. Rockwell. In this test both a steel ball and diamond cone penetrator are used. A minor load of 10 kg. is applied first, after which a dial gauge is set to zero. The major load (normally 150 kg. for diamond cone penetrator and 100 kg. for the 1/16 in. ball penetrator) is added and then removed. The dial gauge reads the Rockwell hardness number directly. Thus, the Rockwell test measures the additional depth to which a cone or ball is driven by a heavy (major) load beyond the depth to which the same penetrator has been driven by a definite light (minor) load. Several different Rockwell scales are utilized to cover the range of hardness of various metals. Each scale is designated by a separate letter of the alphabet which is associated with a particular major load and penetrator. The major loads are 60, 100 and 150 kg. and their penetrators; the 120° diamond or "BRALE" penetrator with an 0.2 mm. radius truly tangent to the cone, and ball penetrators of 1/16, ⅛, ¼ and ½ inch.

The combination of diamond "Brale" penetrator and 150 kg. major load is known as the C scale. It is used for testing all hardened and heat-treated steel. The B scale is the combination of the 1/16 inch steel ball penetrator and 100 kg. load. It is utilized for the testing of unhardened steel, brass, bronze, etc.

During the past year, great strides have been made in perfecting high speed methods of testing the hardness of metals. In the foreground was the development, with many new concepts, of completely automatic hardness testing of small, but not intricate, mass production gears, splines, tools, etc. Of equal im-

(Continued on page 26)



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STEAM ATMOSPHERE HEAT TREATING BOOSTS PLANT OPERATING EFFICIENCY

By **F. L. Spangler,** *Application Engineer*
Leeds & Northrup Company
Philadelphia, Pa.

MANY metalworking plants are realizing substantial savings in tempering, annealing, and stress-relieving through the use of steam atmosphere heat treating. In furnaces specifically designed for this method by Leeds & Northrup, both ferrous and non-ferrous parts receive scale-free heat-treatment at temperatures up to 1250°F. Resultant work has such product advantages as superior wear resistance, longer life, better machinability, and greater corrosion resistance.

In addition to improved properties of the work, steam treating can reduce or completely eliminate many time-consuming finishing operations. This article reviews the basic principles of the method and presents a series of typical applications which should suggest to the reader how this type of heat treatment can be of direct benefit to him. These applications are summarized in Table I.

Steam Treating Equipment

Accompanying application views show how plants install the steam treating furnace and accessory temperature controls, often directly in production lines. The cross-section digram (Fig. 1) identifies basic components of the furnace.

After work is loaded, operation starts with bringing the furnace up to 650 to 750°F with air atmosphere. This preheats work and prevents condensation of steam on cold work. Automatic controls hold this preheat temperature for 30 minutes while injected steam purges air from the work chamber. The load is then heated to soak temperature and held automatically for the specified time, with steam flowing through the furnace.

At the end of the soak, work is either air-cooled or quenched in soluble oil. When handling non-ferrous materials which require lower soak temperatures, the furnace may be purged at as low as 400°F, and parts are often quenched in water.

Cost of furnace atmosphere is low—a few cents per 100 lb. of load, in most plants. For continuous production work, a commonly used furnace size requires about 50 lb. of steam per hour. Steam can come either from a plant line, or a small electric or gas heated steam generator. The steam feeds through an inlet in the furnace bottom and exhausts through a flapper valve in the lid.

As shown in Fig. 1, electric heating is obtained by a continuous run of heavy-gauge spiral wire surrounding the work space. A fan provides forced convection and uniform, rapid heating.

Automatic control of temperature in the work chamber is obtained by precise regulation of electric current to the heating element. A thermocouple, located directly in the work chamber, is connected to the panel-mounted Speedomax recorder-controller. This instrument provides a continuous record of the temperature and, at the same time, proportions heat input according to the load demand.

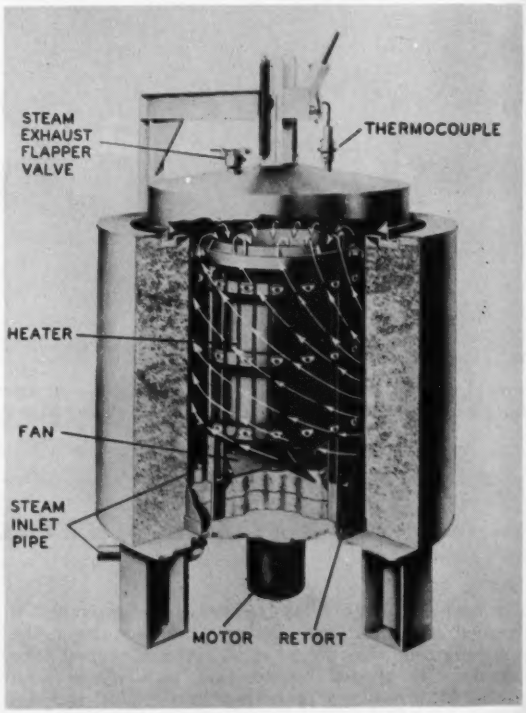


Fig. 1—Cut-away view of Leeds & Northrup Company's "Steam Homo" furnace—a batch-type unit designed for steam atmosphere treating by electric heat and forced convection circulation at temperatures up to 1250°F.

Steel Parts

When hardened bolts and studs, precision steel castings, cold-headed bolts, or deep-drawn parts are tempered in steam atmosphere, they come out clean and free from scale. During heat treatment, the steam forms a tightly-adhering blue oxide coating which

not only protects the parts but also makes an attractive final finish. Thickness of the coating with a 30-minute cycle at 1025°F is about 0.0001 in.

The oxide coating deposited on exposed surfaces during steam treatment has in itself a certain amount of resistance to corrosion. When the part is dipped in oil or other rust preventative, the porous nature of the oxide coating provides a highly retentive surface so that the corrosion resistance of such parts is usually equal to or better than parts treated by chemical oxidizing processes. In other cases, the uniform, blue-black surface obtained by steam treatment has proved a satisfactory substitute for plated parts.

Where parts require plating following heat treating, the oxide film is easy to remove with a short pickle because of its uniform composition and depth. One manufacturer of hardened steel bolts cut pickling time on bolts to be plated by 66% through the use of steam treating.

Powdered Iron Compacts

Steam-treating of sintered powdered iron compacts has as much as doubled their hardness and compressive strength. Resistance to wear improves, also, because the hard oxide partially fills the pores of compacts and offers its own resistance as parts wear down. Here, too, the film's ability to store lubricants improves the wearing-in and corrosion-resistance of oil-dipped parts.



Fig. 2—This twin-furnace installation includes both steam treating and pre-heat units with separate temperature controls for mass production bluing of rotors and stators for hermetically sealed motors. Parts must meet strict surface specifications for color and corrosion resistance.

High Speed Cutting Tools

Drills, reamers, hobs, milling cutters, and other high speed steel cutting tools on many applications hold their cutting edges 50 to 100 per cent longer when steam treated following tempering and final

TABLE I–SUMMARY OF APPLICATIONS–

STEAM ATMOSPHERE HEAT TREATING

Product	Material	Process
FERROUS METALS		
Cams, bearings, valve tappets, pistons, piston rings, etc.	Cast iron	Controlled oxide coating
Saw blades, machine parts	Steel	Controlled oxide coating
Twist drills, taps, reamers, counterbores, punches, etc.	High-Speed steel	Controlled oxide coating
Rotors and stators for hermetically sealed electric motors	Laminated silicon steel	Controlled oxide coating
Postage meter parts, sewing machine parts, guns, toys	Steel	Bluing
Gears, bushings, pistons	Powdered metal	Controlled oxide coating
NONFERROUS METALS		
Cosmetic cases, faucet spouts, radiator vent caps, 30 caliber shells	Brass	Annealing after progressive deep-drawing operations in fabrication
Valves, regulators, gas torch nozzles, fasteners, cosmetic containers, etc.	Brass or Bronze	Stress relieving after machining
Clips, springs, electrical components	Beryllium Copper	Precipitation hardening or aging
Instrument parts	Aluminum alloy	Solution treating

grinding. This increase can be as high as six times as long when the tools cut such extra-tough materials as heat-treated alloy structural grades of steels. The result is fewer tools needed and less time required for changing and sharpening them.

In this case, also, the longer life is attributed to the tough, porous oxide film. Though micro-thin, the film insulates the tool from the machined part and prevents it from loading with chips "welding" near the cutting edge. The oil retaining properties of the oxide film give better point-of-contact lubrication during machining.

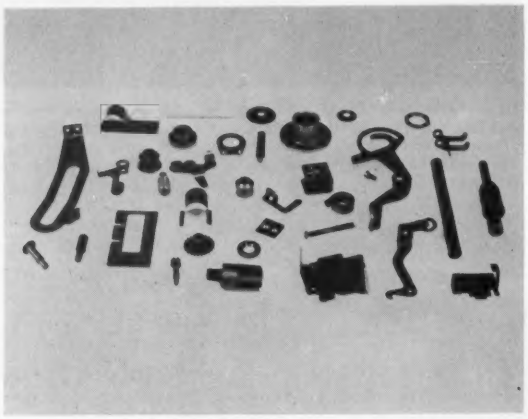


Fig. 3—Steam-bluing of these postage meter parts replaced cadmium plating, and resulted in closer-fitting, smoother working parts. It also reduced finishing costs.

Brasses and Bronzes

Brass and bronze parts—such as valve fittings, fasteners, cosmetic containers, and cartridge cases—anneal and stress-relieve clean in steam atmosphere. Often parts come out clean enough so that additional chemical cleaninig is unnecessary. Parts to be plated require only a bright dip to remove the slight discoloration formed during steam treatment.

In many cases, steam-treating of brasses and bronzes elminates pickling and other surface cleaning operations. One manufacturer of brass stampings realized a saving of 53% in pickling and annealing costs by the use of clean, steam atmosphere without scale. For subesquent plating, they do not require pickling, except for a bright dip to remove the thin oxide film.



Fig. 4—Steam atmosphere treating of these cast iron automotive parts eliminated a chemical surface treatment formerly required for proper lubricating quality. Company also steam treats its high speed steel form tools; gets 50 to 75 per cent longer life before regrinding.

Aluminum Parts

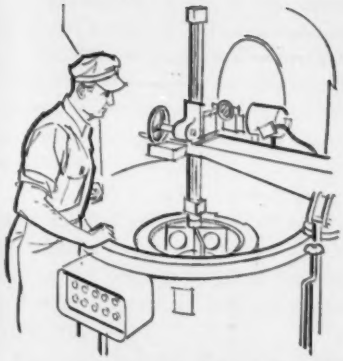
Solution treatment of aluminum alloys in steam gives a more uniform, more reflective surface as compared to the duller, heavy matte coating obtained in air. This means lower finishing costs on parts to be polished. One manufacturer of aluminum clutch arms saved up to 40 per cent of the cost of subsequent buffing operations by the adoption of steam atmosphere treatment.



Fig. 5—Steam solution treating these aluminum alloy clutch arms saves up to 40 per cent of the cost of subsequent buffing operation.

Paint Base

A sewing machine manufacturer employs steam treatment to obtain a practical oxide base for steel and cast iron parts which are to be painted. Assemblies have a satisfactory paint adhesion and are treated at an estimated cost of 20 to 25 per cent less than that required for chemical surface preparation. ■■■



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Gear shown is 18½" O.D., width of face is 2", weight 34 pounds, 73 teeth. Hardness obtained is 55-66 R.C., using 140 K.W. of 10,000 cycle power.

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HIGHLIGHTS OF THE WESTERN METAL SHOW

By **Thomas A. Dickinson,**
West Coast Reporter

METAL treating methods and equipment were outstanding among the features that drew a record-breaking crowd of more than 70,000 persons to the Tenth Western Metal Exposition and Western Metal Congress which were held simultaneously at the Pan-Pacific Auditorium and the Ambassador Hotel, Los Angeles, for a period of five days during the latter part of March.

Other attractions of general industrial interest were exhibits and technical sessions which indicated the potentialities of new nondestructive testing techniques, nuclear reactors and their radioisotopic by-products, structural metals for high-temperature applications, cermets (or combinations of ceramics and metals), and titanium alloys.

The main event for a majority of metal treaters attending the Congress was a second-day technical session on brazing and sintering staged by the Industrial Heating Equipment Association whose public relations committeeman, Elton E. Staples, served as chairman during the meeting.

First of four speakers introduced by Staples was H. M. Webber, process and application specialist in the industrial heating department of General Electric Co., Shelbyville, Ind. Webber extolled the virtues of furnace brazing as a production process and—using both words and color pictures—briefly indicated the materials, methods, and furnaces that make such assembly work practical. Experienced listeners seemed especially interested in his remarks to the effect that nickel alloy brazing materials are being used to produce strong, heat-resistant joints in aircraft engine rocker arms and other articles comprising parts made from ferrous materials.

In subsequent talks, Leon B. Rosseau, vice-president and general manager of Ajax Electric Co., Philadelphia, Pa., explained the significance of salt bath brazing methods; R. L. Harper, executive vice-president of Harper Electric Furnace Corp., Buffalo, N. Y., discussed the furnace sintering of ceramics, metals and metallizing; and W. E. Benninghoff, vice-president and Tocco Division general manager of Ohio Crankshaft Co., Cleveland, Ohio, emphasized the importance of induction brazing and soldering.

"With labor costs at their highest levels and willingness to work at perhaps the lowest in the history of our mass-production industry," Benninghoff pointed out, "the only chance for a return to lower prices will be through adoption of processes and techniques which will reduce man-hour and material costs per unit."

In a number of technical sessions on high-temperature materials, sponsored by the American Society for Metals, the importance of heating equipment was repeatedly emphasized. For example, research engineer John A. Van Echo of Battelle Memorial Institute, Columbus, O., asserted that in the development of such devices as rockets and guided missiles (which have useful lives amounting to no more than a few minutes or even seconds), it is necessary to obtain creep data with new equipment which heats materials by resistance at a very rapid rate and then holds the desired temperature for periods ranging from a few seconds to about three hours.

J. R. Kattus, head of the metallurgy section at Southern Research Institute, Birmingham, Ala., added that in one instance it was necessary to elevate material temperatures from 70° to 1200° F. in only 10 seconds in order to simulate aerodynamic conditions that would be encountered by high-speed aircraft and missiles.

T. C. McGill, senior metallurgist for the Convair-Pomona Division of General Dynamics Corp., further described a furnace test unit which now enables his company to use heated oil to determine how materials will react to kinetic heating effects encountered in supersonic flight.

During a five-day titanium conference, which was also held by the A.S.M., reports on many new alloys and processing methods were made by experts from virtually all parts of the United States. Of special interest to metal treaters were papers read by Lee S. Busch, director of research for Mallory-Sharon Titanium Corp., Niles, O.; Walter H. Bishop, chief process engineer for the same company; D. J. Maykuth, assistant chief of the nonferrous physical metallurgy division at Battelle Memorial Institute; Harold D. Kessler, supervisor of the metallurgical research division at Titanium Metals Corp., Henderson, Nev.; and Daniel Horton Barbour, assistant manager of the products and process development department at Electro Metallurgical Co., Niagara Falls.

However, it was generally agreed by authorities at the Congress that titanium—despite its advantages as a relatively light structural material—is not the only answer to current and future high-temperature problems. As George A. Roberts, vice-president of Vanadium-Alloys Steel Co., Latrobe, Pa., put it:

"The most immediate need is for a steel which can be heat treated to tensile strengths in the range of 220,000 to 280,000 psi. and retain sufficient toughness for landing gear, engine mounts, and other structural applications."

R. B. Gunia, assistant manager of U.S. Steel Corp., Pittsburgh, Pa., and George E. Linnert, research metallurgist of Armco Steel Corp., Middletown, Ohio, were among those who predicted the answer to high-temperature problems will be found in the precipitation hardening of stainless steels.

In a dissertation regarding the heat treatment of 17-7 PH steel and 6AL-4V titanium alloy parts, materials unit chief J. Fred Baisch of Boeing Airplane Co., Seattle, Wash., aroused considerable interest by announcing that:

"Protective (ceramic) coatings minimize oxygen contamination during solution heat treatment in conventional furnaces. Straightening is accomplished during the aging cycle."

Baisch spoke during a meeting held by the Metals Branch of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

In the course of a session sponsored by the American Welding Society, an unusual hardsurfacing technique was described by David B. Rankin of Rankin Manufacturing Co., Alhambra, Calif. It consists of using a specified hardsurfacing material as a welding rod so that it can be deposited on surfaces requiring extra abrasion resistance by means of electric-arc or oxy-acetylene welding equipment.

During another AWS meeting, Glenn E. Faulkner of the metals joining division at Battelle Memorial Institute cited experimental evidence to prove that phosphorus within limits specified for aircraft-quality steels is responsible for low ductility and subsequent material cracking at temperatures below the solidus or melting point.

At an AIME session on light alloys, engineers R. E. Kleint and F. G. Janney of North American Aviation, Inc., Hawthorne, Calif., asserted that severe warpage and occasional cracking in large aluminum parts (which cannot be readily stress relieved by conventional means) have been avoided by the compressive deformation of the parts following heat treatments.

"Stress relief by compressive deformation," they explained, "where it is applicable and properly done, will compare favorably to stress relief (in other alloys) by stretching."

Speaking at a meeting held by the Society for Nondestructive Testing, J. E. Reider of Industrial Nucleonics Corp., Columbus, O., indicated that radioistotopes can (among other things) effectively be used to automate furnaces and related metal treating facilities.

"In all cases," he declared, "greater precision in the control of a process is obtained through the use of non-contacting radiation measurement equipment and automatic controls."

At a later SNT session, Irving J. Feinberg of the U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md., stated that quantitative damage to the tensile properties of 195-T6 aluminum alloy with elongated hydrogen gas porosity has been found to be linear with respect to the intensity of the radiographic appearance of the defect in each instance.

Also, D. C. Worlton of General Electric Co., San Jose, Calif., announced that Lamb waves have been ultrasonically projected in such a way that flaws of the types exisiting near the surfaces of casehardened parts were for the first time consistently and accurately detected.

"A unique feature of this testing method," he maintained, "is that the front surface echo is eliminated from the receiver output, so that shallow flaws can be detected with interrogating pulses of long time duration."

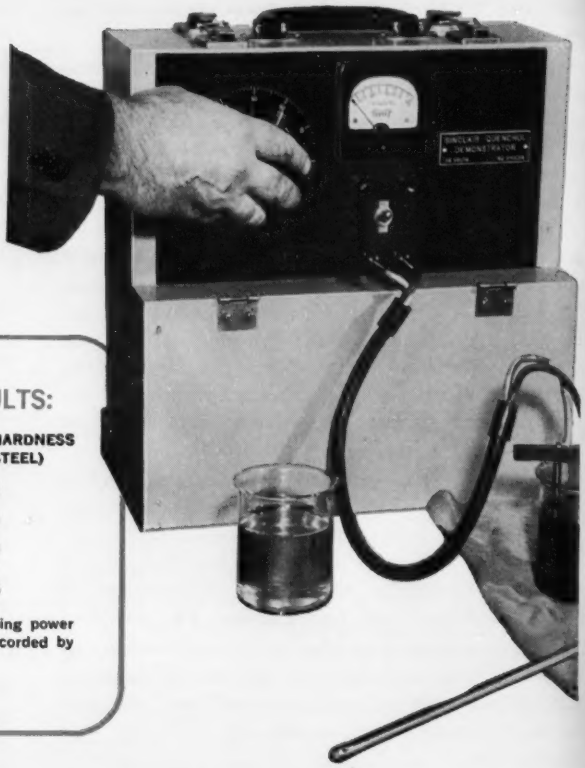
Metal treating processes, equipment, and accessories appeared in more than 60 of 400 displays at the Exposition. ■■■

(For photos of heat treating exhibits see pp. 14-15)

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Competitive Oil C	1024	41.0
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*Based on a recognized formula for determining relative cooling power value. Measured as the square of the current (I^2max.) as recorded by Quenchol Demonstrator.

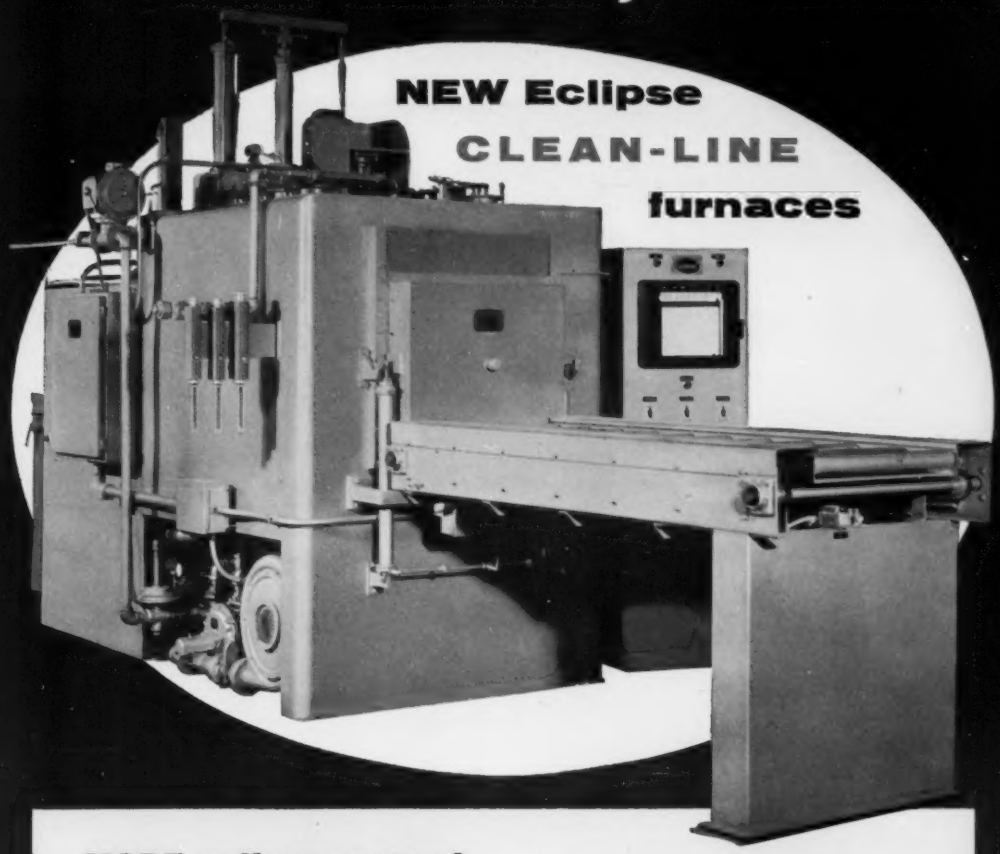
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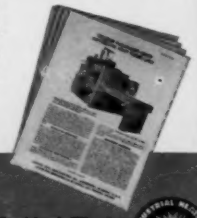


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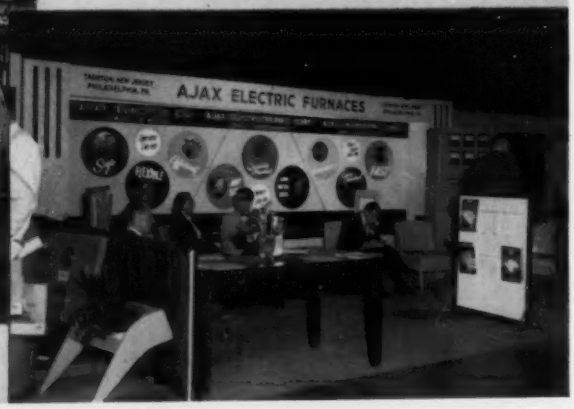




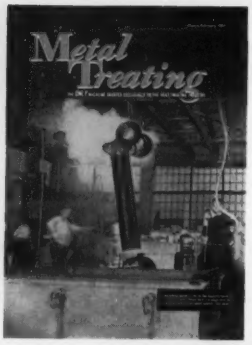








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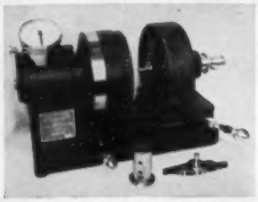
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HEAT TREATING HELP

THE CARPENTER STEEL COMPANY, 198 W. Bern St., Reading, Pa. No. 5 in a series

TORSION IMPACT TEST AS A GUIDE TO HEAT TREATMENT

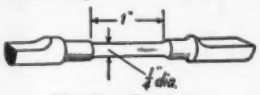
For best results a tool must be hard enough to resist wear, and tough enough to avoid breaking. Users of tool steel have always been conscious of this fact, and have tried to find the heat treatment productive of the best *combination of hardness and toughness* in any given tool. This usually had to be done by expensive cut-and-try methods.



The Carpenter Torsion Impact Machine

Some years ago Carpenter set out to find a method by which the user could quickly and surely determine the best drawing temperature in any particular tool steel to obtain this combination of properties. The answer was the "Carpenter Torsion Impact Testing Machine".

This machine, now widely recognized in tool steel testing, has revealed things about tool steel that were never suspected. It has made possible a simplification of heat treatment that is saving industry a tremendous amount of time and money.



The Test Specimen

Here is a brief description of how the test is made. A piece of tool steel is machined to the shape shown at the left. It is heat treated, and then broken in the testing machine by a torsional impact blow. The energy required to break it is an indication of the torsional impact strength, and is measured in foot-pounds. This value represents simply the amount of work or energy required to break the specimen, and as such it involves two things.

First, the force, which will be proportional to the hardness of the steel.

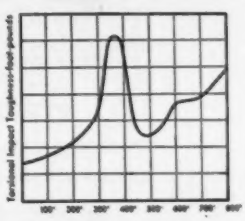
Second, the distance through which the force acts, which will be related to the amount of bend or twist the specimen takes before it breaks.

Thus, the test shows us the combination of the two things we are interested in, namely the physical strength of the material and the amount of flow or twist possible before breaking.

To illustrate the use of the torsion impact machine, suppose we want to know how different drawing temperatures affect the torsion impact strength of a plain high-carbon water-hardening tool steel.

To get the answer, we first machine a lot of torsion impact test pieces, then harden all of them in exactly the same way and finally *draw them all at different temperatures.* When we plot on a curve the torsional impact values required to break the specimens, we get the answer to our question.

Observe that the impact value as quenched is very low, but increases rapidly as the drawing temperature is raised to 350-375°F. Then it falls off rapidly again at higher drawing temperatures until it is less than half the peak value. The reason the curve increases to a peak at 350°F is that the steel is being toughened by the draw up to that point, and when drawn at 350°F the test piece actually twists appreciably before breaking, even though it shows a Rockwell hardness of C-64. Then as the drawing temperature is increased from 350°F to 500°F there is a distinct decrease in the amount of twist before breaking, and this causes the rapid fall of the impact curve through this range of drawing temperature. If the drawing temperature is now increased above 500°F, the amount of twist before breaking increases very rapidly. But through this range, the hardness or strength of the material *is decreasing rapidly*. So while the twist is greater, the amount of energy required to break the specimen *is less*. This offsets the greater twist to the extent that the curve does not rise as rapidly as the original curve up to 350°F. Because of this fact, the torsion impact curve is not as important in tool steels drawn at the higher temperatures where the steel is in the softer condition; its greatest help is in the drawing ranges in which the steel remains extremely hard. Furthermore, since steels of different composition differ in their behavior on drawing, it is not possible to compare the impact peaks of two steels having entirely different type analyses. The curve is thus most valuable in determining for any one steel the drawing temperature which will yield the maximum hardness with the best toughness.



Drawing Temperature—Degrees F. (1 hour at heat)

Hundreds of such curves have been made on the extremely hard tool steels, and every one that has been tested shows either one or two such impact peaks. Practical experience over a period of years in commercial tool rooms shows that a good hard tool will usually give the best results when drawn at the temperature which produces the peak. In this way the torsion impact curve has been a very valuable guide.

Throughout the Carpenter Matched Tool Steel Manual we give the torsional impact curve for steels in the Oil-Hardening, Water-Hardening and Air-Hardening Matched Sets. The important things to keep in mind in using these curves are:

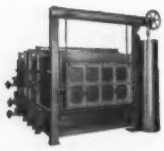
1. That they are most significant for drawing temperatures resulting in high hardness values.
2. That they are most valuable in picking the best drawing temperature in any one steel.
3. That comparisons should not be made between the curves of different steels.

In the Red-Hard Matched Set, torsion impact curves are not given because these steels operate at elevated temperatures.

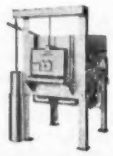
The torsion impact peaks are important guides to proper drawing temperatures, and if you will always start out by using these preferred temperatures, you will eliminate a tremendous amount of cutting and trying, and thus greatly improve the average performance of your tools and dies.

The five Heat Treating Help instruction sheets which have appeared in this series have been reprinted in a booklet entitled Simplified Heat Treatment of Tool and Die Steels. You may obtain a copy for your personal file by writing on your company letterhead to The Carpenter Steel Co., 198 W. Bern St., Reading, Pa.

SURFA



large oven



small oven



laboratory



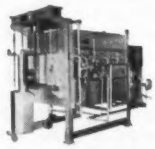
circular pot



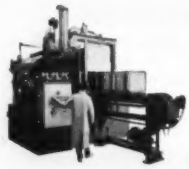
rectangular pot



forge



balco® atmosphere



allcase® atmosphere



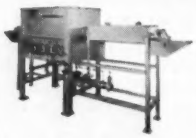
horizontal muffle



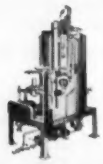
vertical muffle



brazing



sintering



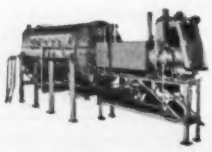
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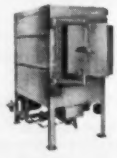
MAX® atmosphere generator



stainless steel



rivet heater



horizontal convection

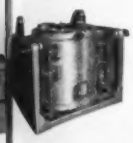


vertical convection



direct air heated

C E



ng metal melting



stationary
metal melting



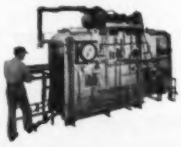
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Right Or Wrong In

LABOR RELATIONS

If Two Employees Engage in Horseplay, Should They Both Be Fired?

What Happened:

Roy Olson was a "card." He liked to fool around and tease people. His specialty was teasing the female employees in his department. His supervisor talked to him a few times but never took any other action.

One day Olson picked up an empty wire spool and "playfully" tossed it at Mary Wellus. It hit her in the thigh. She wheeled around, grabbed the spool up off the floor, wound up like a pitcher and heaved it back at Olson. The toss narrowly missed the head of another worker. The foreman felt he'd had enough of this sort of nonsense, and fired both employees.



Olson took what was coming to him without complaint, but Mary filed a grievance. She argued:

1. I didn't start the horseplay, so I shouldn't get the same penalty as Olson.
2. I got no warning. Supervision knew that horseplay was going on and never did anything about it.

The company backed its supervisor. It maintained:

1. Mary's action almost injured another worker.
2. She should not have reacted in kind but should have told her supervisor about Olson's childish behavior.
3. She knew that horseplay is a serious offense. It is in the company rule book.

Was Mary: RIGHT ☐ WRONG ☐

What Arbitrator Harold C. Havighurst, Chairman, Arbitration Board Ruled:

"Roy Olson, from the time he came to Warwick, had enaged in a vicious form of teasing directed toward all female employees who worked in his vicinity; he had subjected Mrs. Wellus to repeated annoyances; supervisory employees had known of this situation at least to some extent, and they had done nothing about it. These facts place a measure of responsibility upon the company for the incident, which we believe it is proper to take into account in connection with the question of justification for the discharge. Mary Wellus should be reinstated without loss of seniority and with back pay."

Can You Give Employee Warning Notice for Arguing with His Supervisor?

What Happened:

Fred Muller was a welder, and when he finished a job at 4:10 in the afternoon, his foreman told him to start on another assignment. "I've only got 10 minutes to wash-up time," Muller protested.

When the foreman insisted that Fred do as he was told, the worker continued to argue. He did this for 10 minutes. By then it was wash-up time and he left for the locker room. The foreman gave him a warning notice for insubordination. Fred protested:

1. I had a grievance and I had a right to talk to my foreman about it.
2. I told him that it was no use starting a job 10 minutes before wash-up time because I wouldn't get it finished.

The company felt that Fred was stalling in the first place, and secondly, if he had a grievance, he should have obeyed the supervisor's order—and then filed a grievance later on.

Was the Company: RIGHT ☐ WRONG ☐

What Arbitrator Robert R. France Ruled:

"It is likely that Muller felt strongly that the foreman was being unfair in insisting that the work be started. He therefore was unwilling to accept the foreman's decision without further attempts to change his mind. But to permit a worker to continue to argue with his foreman after a reasonable length of time could result in disruption of the work process and an undermining of the foreman's authority.

"The contract provides a grievance procedure to protect workers from unfair decisions by supervisors. The grievance procedure also is instituted to settle differences of opinion without disrupting operations. If Muller felt that the foreman's decision was unfair, he still should have obeyed it, and then obtained redress by submitting a formal grievance. Instead, he continued to press his case for what, in the opinion of the arbitrator, was an unreasonable length of time. In the process he thwarted the foreman's attempt to get the work started. Grievance denied." ■■■

HEAT TREATING HINTS

AUSTENITIZING

The Key to the Hardening Reaction

In the March-April issue this column discussed the preheating step of the heat treating cycle; therefore, it is only natural that this discussion be centered around the austenitizing or high heat phase of the heat treating operation. Basically the austenitizing treatment controls the exact hardness which will be obtained, determines the eventual size change, develops the red hardness, and brings out many of the other desirable metallurgical characteristics which are designed into the steel by the chemical composition. Unquestionably then, the austenitizing step is the key to the entire heat treating operation.

For the purposes of this article, it is assumed that adequate protection of the steel surface against carburization, decarburization, and excessive scaling has been afforded by suitable means. While the importance of proper surface protection during austenitizing cannot be minimized, we feel it is a subject deserving of special consideration and therefore will be reported upon separately in a later issue.

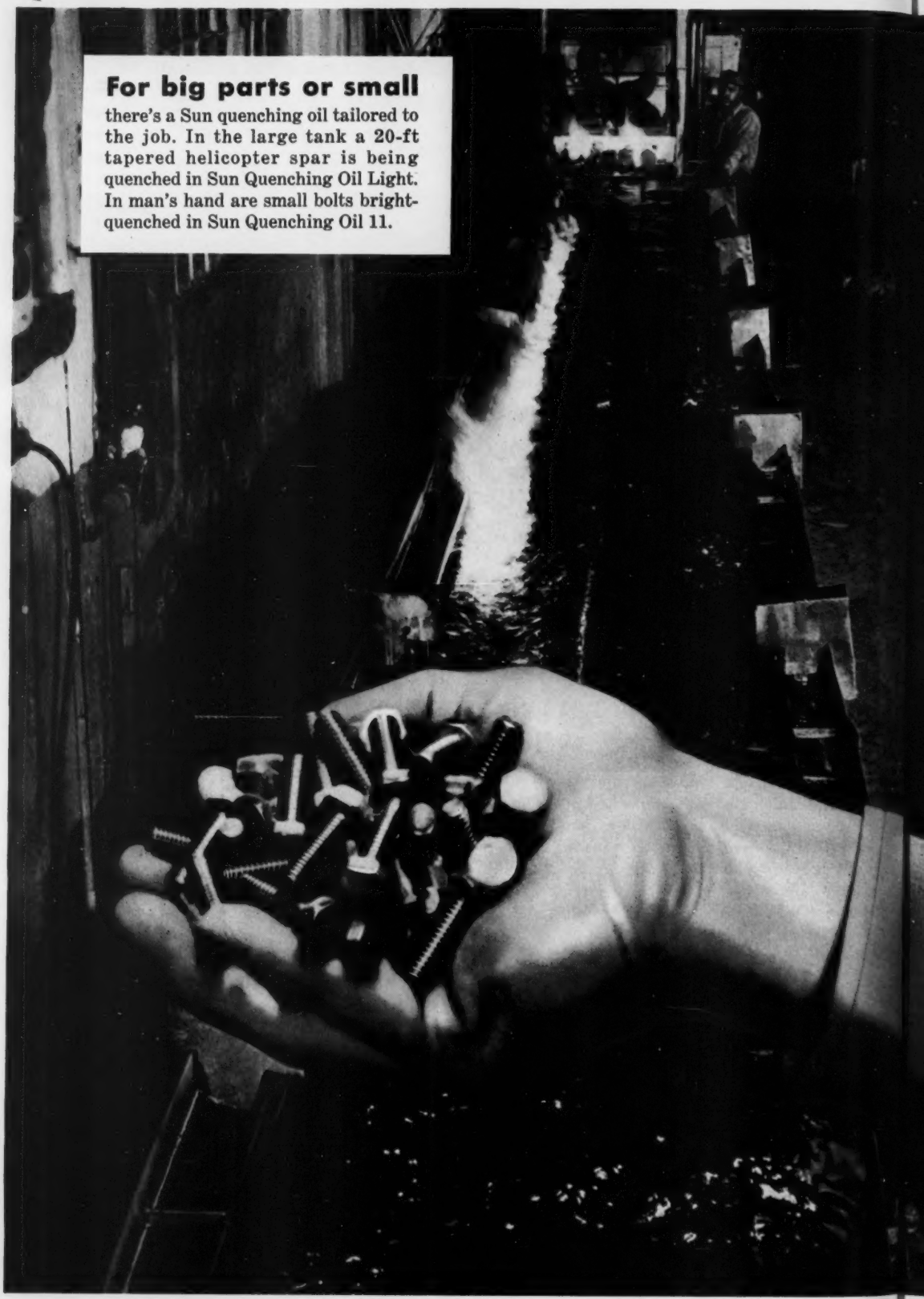
Austenitizing is a time-temperature dependent reaction, although the more important of these by far is the temperature factor. In developing heat treating data for a new steel analysis, the steel manufacturer carefully determines the proper temperature range to employ and uses a relatively broad latitude for the time factor. As a result, it is difficult to overheat a piece of steel during austenitizing by using too long a time at temperature *providing that the temperature of the steel is within the recommended hardening range.* It has been our experience that overheating usually occurs as the result of excessive temperature, not excessive soaking time, and that most of the problems associated with austenitizing result from undersoaking rather than oversoaking. Obviously, this points up the need for accurate pyrometry control of the heating medium with a minimum of temperature fluctuation in order to assure optimum heat treating results. When higher than normal austenitizing temperatures are used, either intentionally or inadvertently, the time factor becomes increasingly important and the final heat treating results tend to be erratic and difficult to predict with any degree of accuracy.

Carbon and low alloy tool steels which are austenitized at relatively low temperatures depend upon the solution of iron carbide in austenite for their hardening characteristics. Austenite readily dissolves iron carbide and therefore considerable latitude is permissible with respect to both time and temperature in heat treating these types of steel. The danger of undersoaking is greatly minimized because of the ease of carbide solution, and usually it is necessary only to insure that the steel is uniform in temperature and within the proper hardening temperature range to obtain fully satisfactory results. Soaking times for these steels are quite short, approximately only five minutes per inch of thickness, although longer times certainly are not detrimental.

Higher alloyed die steels, and particularly the high carbon–high chromium types, are much more sluggish in dissolving carbides. The soaking time should be correspondingly increased over the low alloy steels so as to avoid the danger of undersoaking. With furnace hardening, a soaking time at temperature of 30 minutes for the first inch of thickness and 10-15 minutes for each additional inch is a good rule of thumb to follow. Regardless of how small the size may be, the minimum soaking time should not be less than 20-30 minutes. Pack hardening requires additional soaking and the long established rule of one hour per inch of thickness normally is followed. Here again, soaking times longer than these are in no way detrimental to the properties of the steel, and the pitfall to avoid in treating these types of steel is undersoaking rather than oversoaking.

High speed and modified high speed steels depend upon the solution of various complex alloy carbides during austenitizing to develop their outstanding heat resisting qualities. These alloy carbides do not dissolve to an appreciable extent unless the steel is heated extremely close to its melting point. As a result, exceedingly accurate temperature control for austentizing is mandatory. The factor of time in the austenitizing reaction also is of greater importance than it is with lower alloy steels hardened at temperatures below 2000°F. Because of the importance of both time and temperature, considerable skill and experience on the part of the operator is required to properly austenitize high speed steel. No hard or fast rules exist as they do for other steels. In general, however, heavy duty type tools are hardened from the high side of the recommended temperature range while fine edge tools are austenitized on the lower side. The soaking time for austenitizing also will vary somewhat but normally is in the range of 2-5 minutes at temperature. These are only general considerations, and each grade of high speed and each type of tool should be handled on an individual basis both for time and temperature. In this regard, experience and results are the best guide to follow.

Source–Latrobe Steel Company



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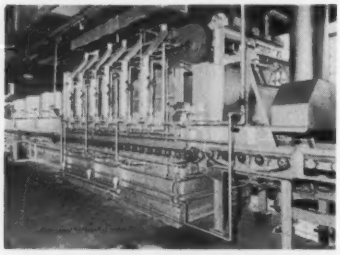
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IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

NEWS TO HEAT TREATERS...

BRIGHT ANNEALING OF COPPER TUBING

Roberts Tube Division, Prestyle Manufacturing Company, Detroit, Michigan, has added new and expanded facilities to their manufacturing operations to answer the demands of those who use copper tubing in installations and who insist that the tube be annealed bright, clean, and dehydrated, and to bend easily.



Complete mechanical handling and controlled atmosphere treating are a feature of Roberts' new equipment, built by Holcroft & Company, Detroit, Mich. It is 100′ long, 15′ of which is devoted to heating, 50′ to cooling, and the remainder to loading and unloading. The tube moves through the furnace on power driven rolls. Both straight lengths and coils are handled varying in size from tiny capillary to 3″ O.D. tubing. Coils range from 6″ to 39″ in diameter; and up to 20′ straight lengths are processed.

The stock is delivered to a charge table consisting of a set of rolls which can be operated independently from the furnace conveyor by a manual clutch arrangement. Furnace heating is achieved by 12 sealed-head return-bend radiant tubes controlled in two zones. An exothermic atmosphere controls gas make-up according to the stock being processed. The heating atmosphere around the stock is circulated by 3 impeller fans.

Protected by a gas atmosphere, the tubing then moves through a watercooled tunnel. A refrigerating machine is coupled with the cooling jackets to control temperature and save water.

The furnace atmosphere is provided by a Holcroft exothermic generator with a capacity of 10,000 cfh, which utilizes an air-gas mixture burned in a combustion chamber. Heating and cooling periods are controlled by a variable speed drive; if the time in the high heat chamber is 20 and 30 minutes, the corresponding cooling period may be fixed at between 1½ to 2 hours.

For further information circle No. 1

SMALL VACUUM FURNACE

High Vacuum Equipment Corporation of Hingham, Massachusetts, introduced a new concept of vacuum furnace design with their new laboratory vacuum furnace. Ready interchangeability of furnace components make this unit suitable for melting, annealing, brazing, sintering, and degassing. A wide variety of optional accessories and controls are also available which make the furnace extremely versatile. The standard model is a compact, completely self-contained unit with a 3″ ID x 6″ high stabilized zirconia crucible.

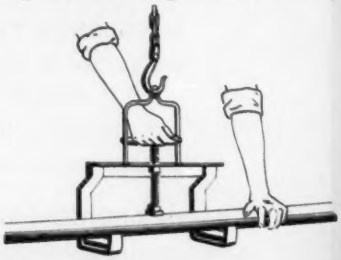
Using the same cabinet, power supply and pumping system, the melting furnace becomes a heat treating, annealing, brazing, or sintering furnace by removing the melting chamber and substituting a horizontal type muffle furnace having a hot zone of either 6″ ID x 12″ long or 6″ ID x 24″ long for processing at temperatures up to 1050°C. The spherical chamber assembly can be removed in a few minutes and replaced with the muffle furnace. These furnaces are equipped with cooling chambers, provision for gas-inletting, and indicating controllers. Special instrumentation and a 6″ water cooled gate valve to isolate the cooling chamber from the hot zone are available as optional equipment. An adaptor can also be supplied to utilize the pumping system for evacuating other vessels.



For further information circle No. 2

BAR STOCK HANDLER

The "Bar-Lugger", a new type bar stock handler now available through Industrial East Co. is said to speed up and simplify the moving and handling of bar stock by 60% in and out of pigeon-hole storage bins. Its chief feature is to save workers' effort, reduce handling time for production, and give more safety to workers.



The bar is securely picked up by BAR-LUGGER, and clamped on the V roller.

For further information circle No. 3

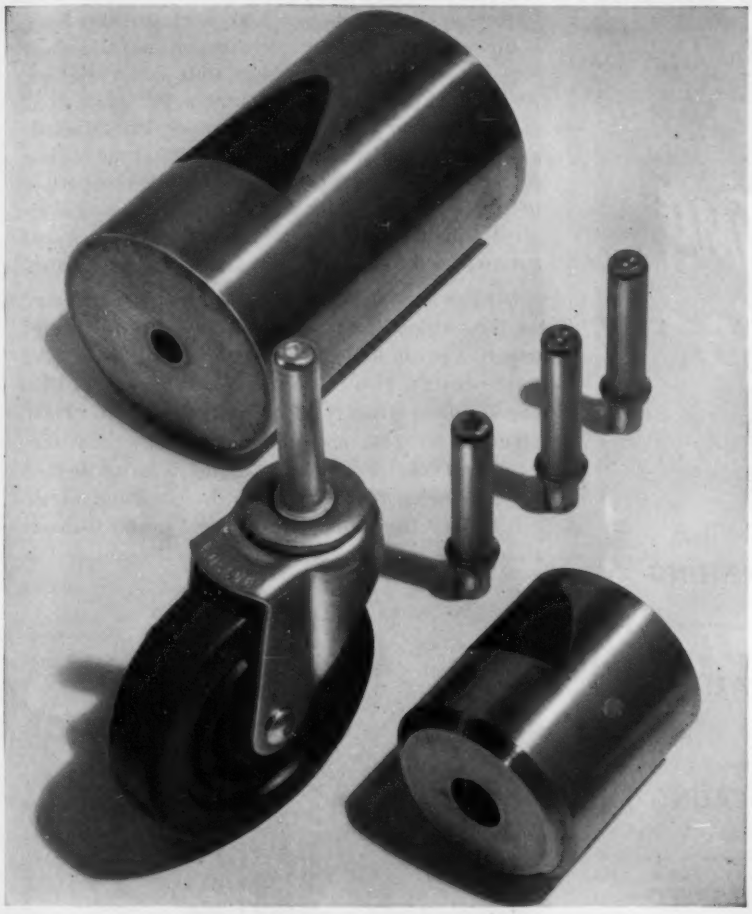
COBALT DEVELOPMENT INSTITUTE

The first General Assembly of the Cobalt Development Institute, created on January 16, was held in Brussels, Belgium, recently. The following officers were elected: Mr. Robiliart (Administrateur délégué of Union Minière du Haut-Katanga), Chairman of the Institute; Mr. E. C. Baring (Director of the Rho-

(Continued on page 30)

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.



Maker of Casters Gets Good Results with Water-Hardening Steel

The Bassiek Company, Bridgeport, Conn., a leading manufacturer of casters, needed a good grade of tool steel for the dies and punches used in producing caster stems. They took the problem to Lindquist Steels, Inc., their local tool-steel distributor, who recommended Bethlehem W-1 Carbon Water-Hardening tool steel for cold-heading purposes. The performance of this grade, with its controlled hardenability, has been excellent.

The dies and punches, some of which are illustrated above, are hardened to about Rockwell C-60, and work on Bethlehem Cold-Heading Wire. They have proved economical, as their service life is approximately 100,000 pieces.

Bethlehem Carbon Water-Hardening tool steel has high shock-resistance because it is carefully controlled for hardenability. Besides, with its controlled carbon range, it has good resistance to wear, plus the toughness to withstand cold battering.

There may be one or more applications in your shop where Bethlehem Carbon Water-Hardening tool steel could be used to advantage. Why not talk it over with your Bethlehem tool steel distributor?

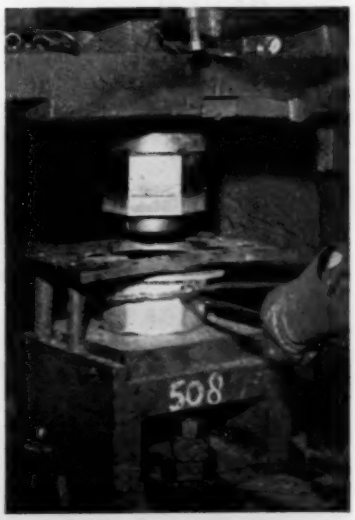
BETHLEHEM TOOL STEEL ENGINEER SAYS:



Bend Tool Steels While They're Hot

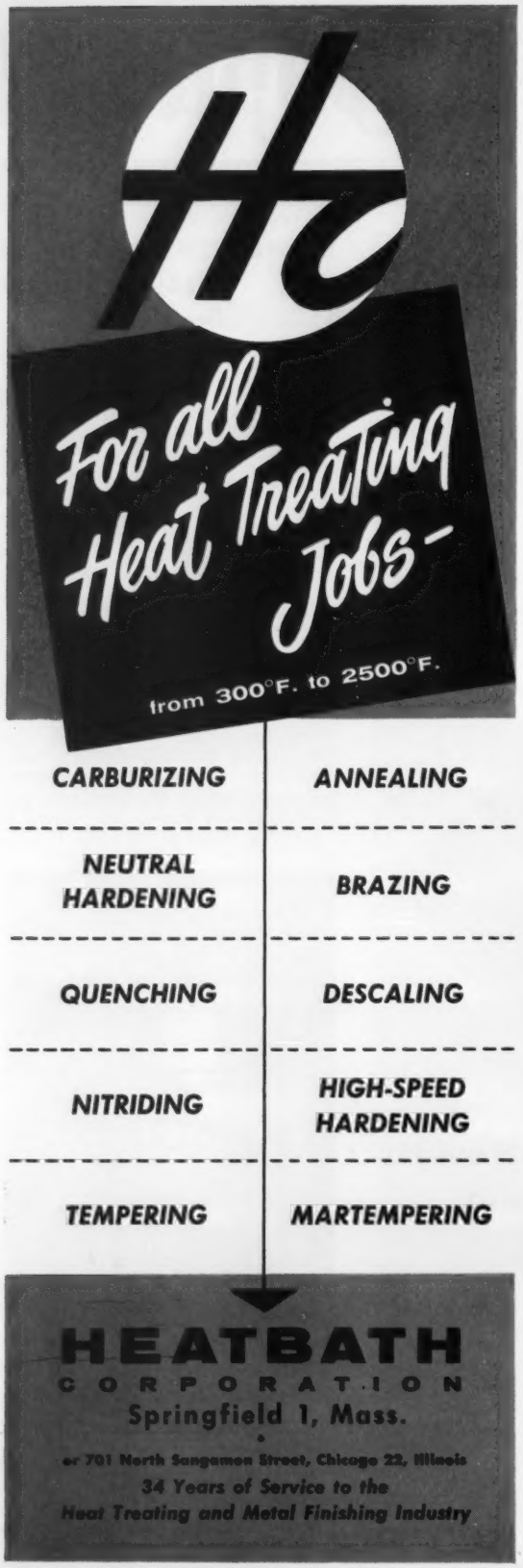
The structure of machinery is such that parts are sometimes fabricated of steel which has been cold-bent to shape. However, when some of the components are made of tool steel, bending usually cannot be done at room temperature without causing breakage. Some degree of heating must therefore be employed.

For severe bending, such as bending to a small diameter, the tool steel is usually heated to the full forging temperature. Depending upon the grade, this may be 2000 F or higher. Moderate bending (curving into a shape similar to a leaf spring) can take place after heating to about 1300 F, being careful that the maximum temperature reached does not exceed the critical temperature. Very light bending operations (perhaps bending a shear blade to compensate for expected warpage in heat-treatment) can be accomplished at room temperature if a generous radius of curvature is used.



Making 36-lb Nut Behave

Here is a shaving die, made of Lehigh H tool steel, used in hot-broaching the sides of a 4¼-in. hexagon nut. Lehigh H is our special-purpose high-carbon, high-chromium grade of tool steel. Its excellent wear-resistance and red hardness make it an ideal steel for this application.



HARDNESS MEASUREMENT

(*Continued from page 4*)

portance was the development of a high-speed automatic Rockwell hardness tester, Fig. 3.

This machine is equipped with a Syntron vibratory hopper for automatic loading, and sorts the pieces into three classifications—too hard, too soft, or satisfactory—at the rate of up to 1,000 work parts per hour. Pan loads of work pieces are dumped into the vibratory hopper, from which they slide down a chute. An electrically actuated rod pushes the pieces, one at a time, into testing position and simultaneously pushes a tested piece into the unloading chute leading to the three classification boxes. With the part to be tested resting on the anvil, the minor load is applied automatically, the major load is applied and removed, and the difference in indentations measured.

On this automatic tester, a light source mounted on the outside of the dial indicator case is directed toward a prism located on the pivot arm of the indicator needle. This prism transmits the beam of light toward the periphery of the indicator dial. Here, photo-electric cells are precisely located so that they will be affected individually by the reflected light if the part being tested is too hard, acceptable, or too soft. The cells, in turn, actuate gates in the discharge chute so that the parts will fall into the proper bin.

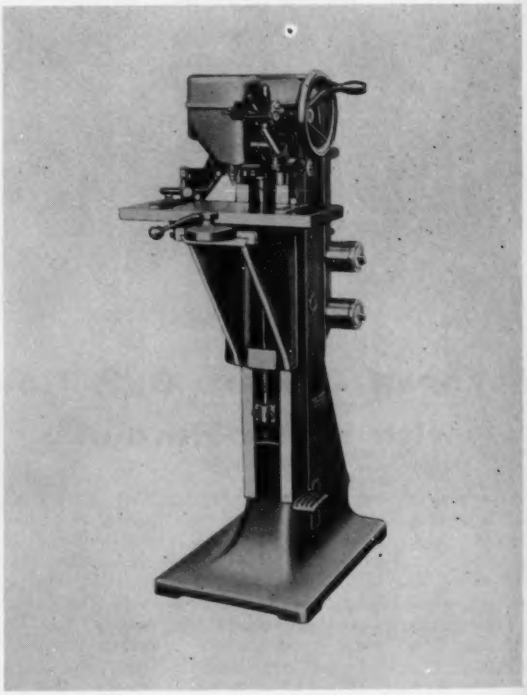


Fig. 5—This unit can be utilized for conducting the 136 degree Diamond Pyramid hardness test, commonly called the Vickers Hardness Test. In testing, this deivce follows the Brinell principle. *Photo courtesy of Riehle Testing Machines.*

Indicator lights are also provided on the tester to visually show results. Parts having variations in thickness up to 3/8 inch can be accommodated without major modifications. The machine is equipped with two counters, one for daily or hourly output, and the other for the accumulated total production. When not required for high-production parts, the tester can be used for semi-automatic or hand-fed operation.

The Rockwell superficial tester, Fig. 4, a specialized form of the Rockwell test, operates on the same principle as the normal model Rockwell tester. However, the minor load is reduced to 3 kg. and the major load to 15, 30 and 45 kg. The same 1/16 inch ball penetrator is used on brass, bronze and unhardened steel. On hard surfaces, a diamond "Brale" penetrator is used. Because of the smaller penetration, the radius of the penetrator must be ground with still greater micrometric precision and is designated as the N "Brale" penetrator.

This superficial tester has its own scales and they are designated first by the value in kilograms of the smaller load used; second, by a letter N (to designate the type of penetrator, if the N scale is used, or the letter T if the 1/16 ball is the penetrator), third, the dial reading.

The 136 degree diamond pyramid hardness test, commonly called the Vickers test, see Fig. 5, follows the Brinell principle in that an indenter of definite

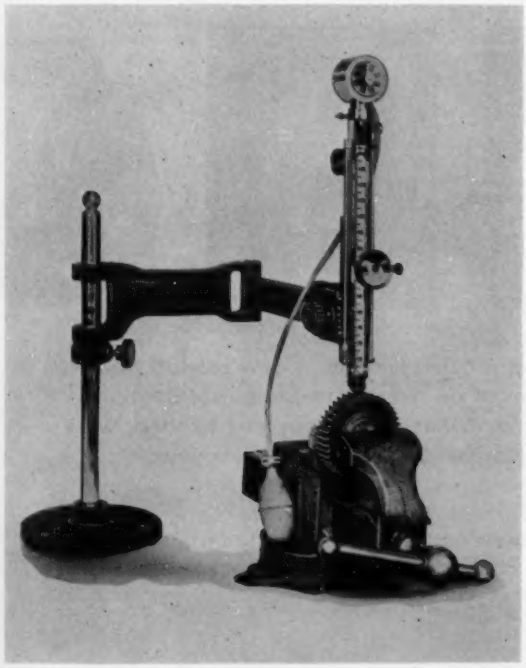
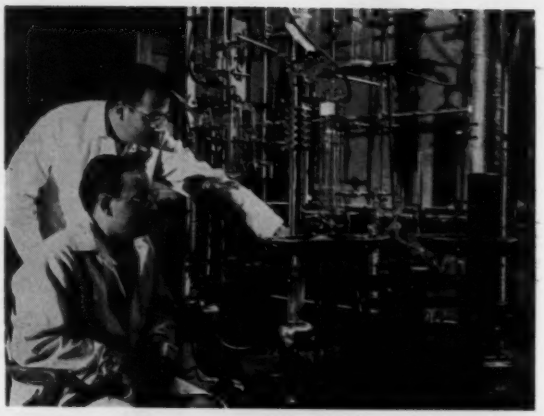


Fig. 6—The Scleroscope is a dynamic form of hardness tester. It is often used for the testing of large and bulky work pieces, especially where the instrument must be brought to the work. Here, the unit is measuring the hardness of gear teeth. *Photo courtesy of Shore Instrument & Mfg. Co.*

(Continued on page 36)



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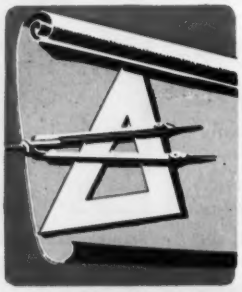
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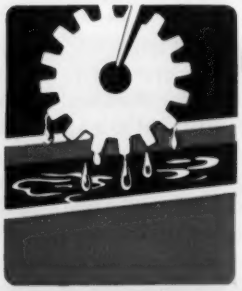
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6 reasons for checking you

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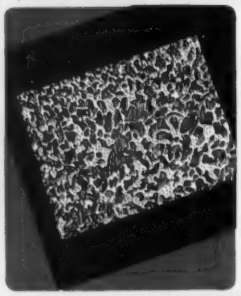
1 Guidance in Steel Selection and Design

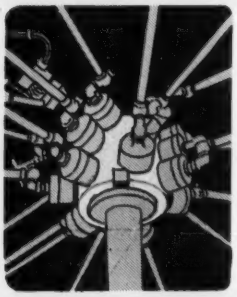




4 Knowledge thro Experience of th Right Heat Trea for the Job

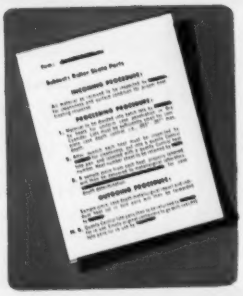
2 Metallurgical Understanding of Metal Properties





5 Extensive arra of Equipment and Facilities

3 Assistance in Proper Preparation of Parts for Heat Treating





6 Final Laboratory and non-destructive Testing

Whenever your production requirements for a new product or the redesign or improvement of an old one mean the installation or expansion of heat treating activities, it will pay you to check with your Commercial heat treater before tackling the job yourself.

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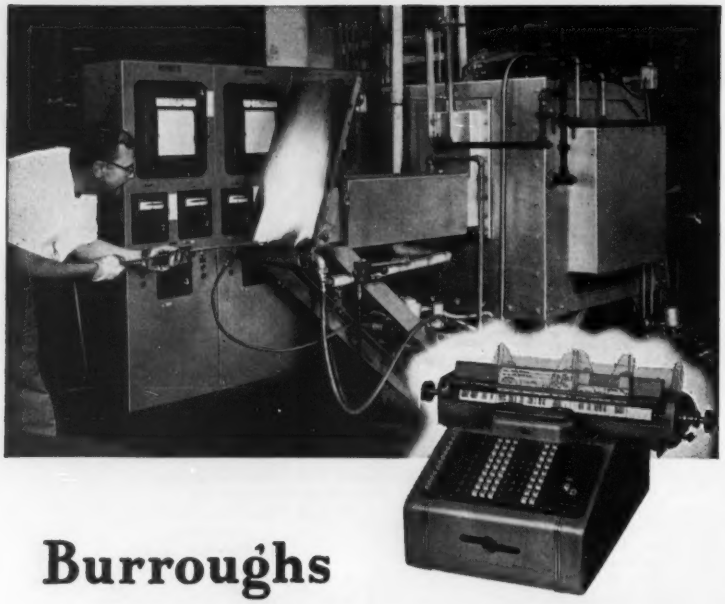
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6. Long element life saves maintenance costs, reduces down time.
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To complete their tool room department, Burroughs uses; two Hevi-Duty Multi-Range Furnaces for hardening and annealing steels other than high speed; two Hevi-Duty Salt Pot Furnaces for drawing and tempering tool steel; a Hevi-Duty Box Air Draw Furnace for drawing all steels; and a Hevi-Duty Pot Furnace for local hardening.

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NEWS TO HEAT TREATERS

(Continued from page 24)

kana Corporation, Ltd.), Vice Chairman; and Mr. Ch. Piedboeuf (Chairman of the Centre d'Information du Cobalt), Vice Chairman.

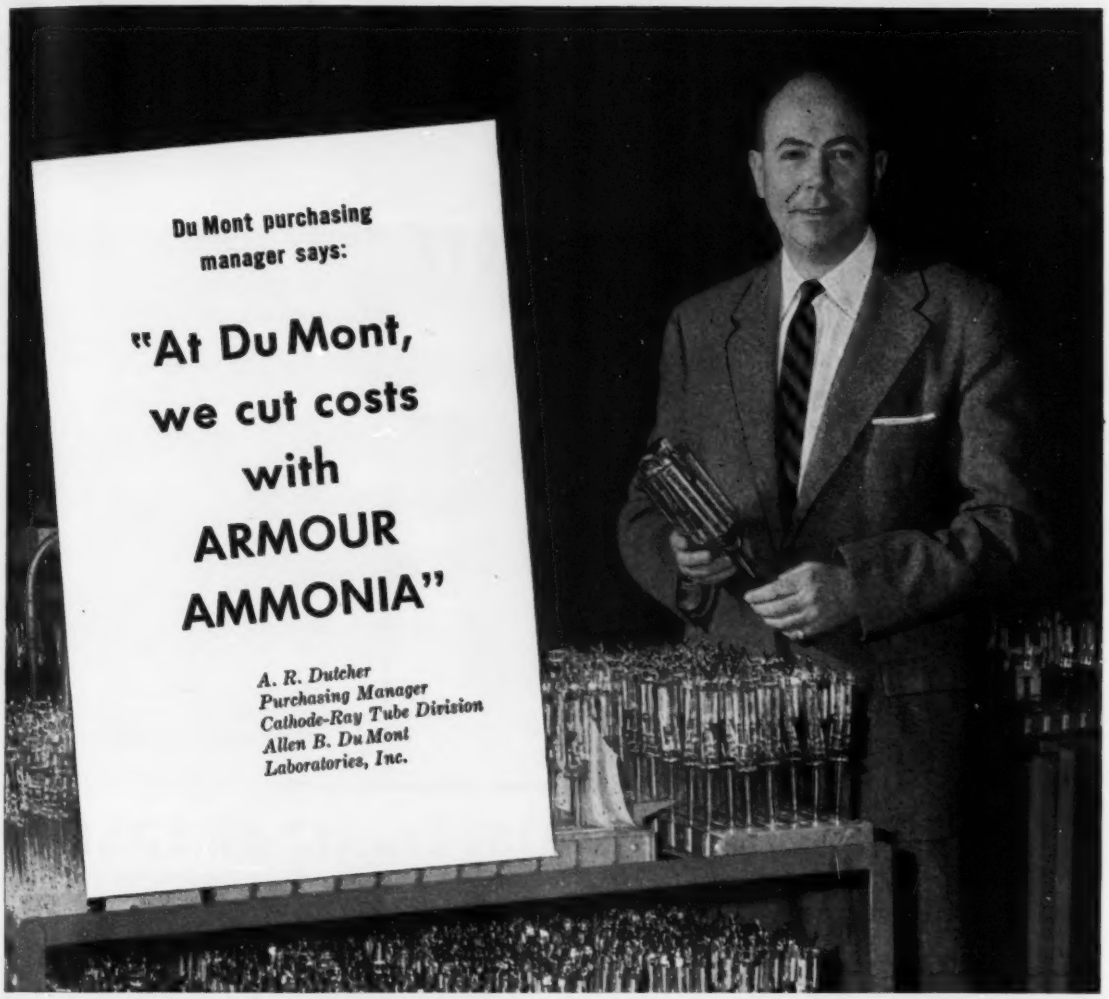
The Cobalt Development Institute is a technical and scientific organization, made up of the world's major cobalt producers. Its object is to improve the existing uses of cobalt and to develop new ones. The Belgian limited liability company "Centre d'Information du Cobalt" has been entrusted with the execution of the Institute's program. The Centre is located in Brussels, at 35, rue des Colonies, and is represented in the United States by the "Cobalt Information Center" at the Battelle Memorial Institute in Columbus, Ohio. A research program of fundamental studies is being sponsored and, through the dissemination of technical data, these informational centers assist users and potential users of cobalt.

GAS STRAINER

Watts Regulator Company, Lawrence, Mass., announces a new low-cost, all-brass strainer. The strainer is designed for applications requiring fine straining of air or gases and is particularly suited for keeping regulators clean. The removable strainer element is indestructible porous bronze which effectively strains out particles .004" and larger (90 microns). Available in pipe sizes ¼", ⅜", and ½". Suitable for pressures up to 500 psi.



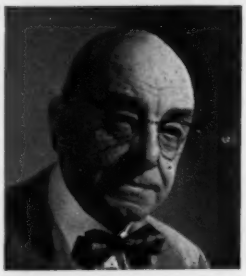
For further information circle No. 4





"Armour Ammonia helps Atwood meet strict customer specifications."

Wilhelm Olson, Metallurgist
Atwood Vacuum Machine Co.
Rockford, Illinois



"Armour technicians helped solve our ammonia problems at Benrus."

Verner R. Lundquist
Plant Engineer
Benrus Watch Company, Inc.

"IT ISN'T easy to cut material costs and still maintain a top quality product.

"But we did it—with the help of Armour Ammonia.

"*Problem:* Our process for bright-finishing component parts in our TV tubes cost too much. *Solution:* with the help of Armour field engineers Du Mont installed a cracking plant. This process cut production costs while maintaining the top quality of our finished products.

"The cooperation of Armour in setting up the Du Mont process, the dependable quality of their ammonia, plus prompt delivery service adds up to complete customer satisfaction."

For 99.98% pure ammonia, backed by unexcelled technical service, call your nearest Armour sales office—or write directly to Chicago for complete information.

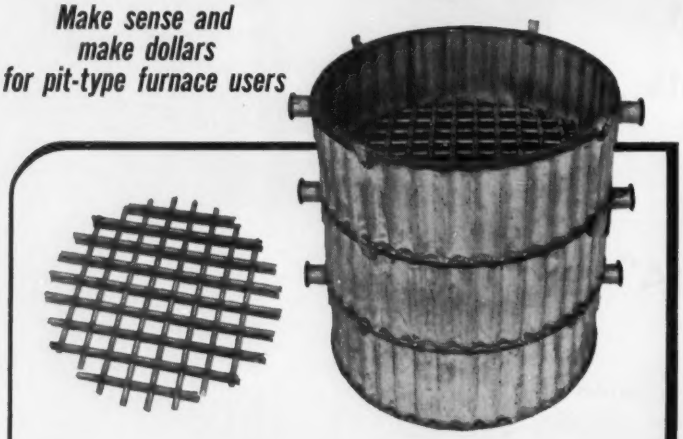
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HEAT AND CORROSION RESISTANT

Make sense and make dollars for pit-type furnace users



ROLOCK'S unique CORRUGATED construction

with pressure-welded truss-type grids

There are many good reasons why these new furnace baskets out-perform and outlast older types. ROLOCK's Corrugated Construction gives high strength with light weight and this, in turn, means less material to bring up to temperature with faster, more uniform heat transfer . . . and a higher ratio of pay load to basket weight. Such baskets mean a substantial saving in furnace time because of faster recovery and, in some cases, an increase in average load as well.

ROLOCK's specialized Welded Fabrication takes full advantage of this construction in every respect. The grid, for example, is built up from rounds rather than flats by a ROLOCK-developed pressure-welding method. Experience shows that such grids are far better able to withstand thermal shock. They may be reversed as required, to compensate for deflection, without cracking.

In this field, as in many other specialized applications of welded-fabricated heat-resistant alloys, ROLOCK's exceptional facilities and skills often promise major operating savings. Write us outlining your problems.

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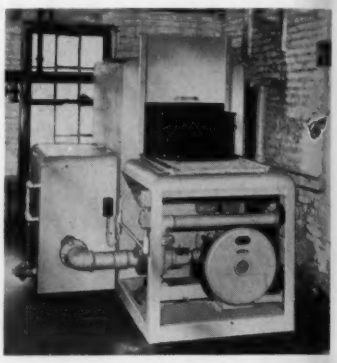
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JOB-ENGINEERED for better work
Easier Operation, Lower Cost

6RL57

HEAT TREATING WASHING MACHINE

The Waukee Washer is a new development of Waukee Engineering Co., Inc., Milwaukee, Wisc. Designed especially for the heat treating industry, this packaged spray-type washing machine is manufactured in standard sizes to fit the popular 24" x 36" x 15" carbo-nitriding furnace trays. It is also available in 24" x 48" x 18" size, and all are available with optional door openings of 20," 22" and 24" high.

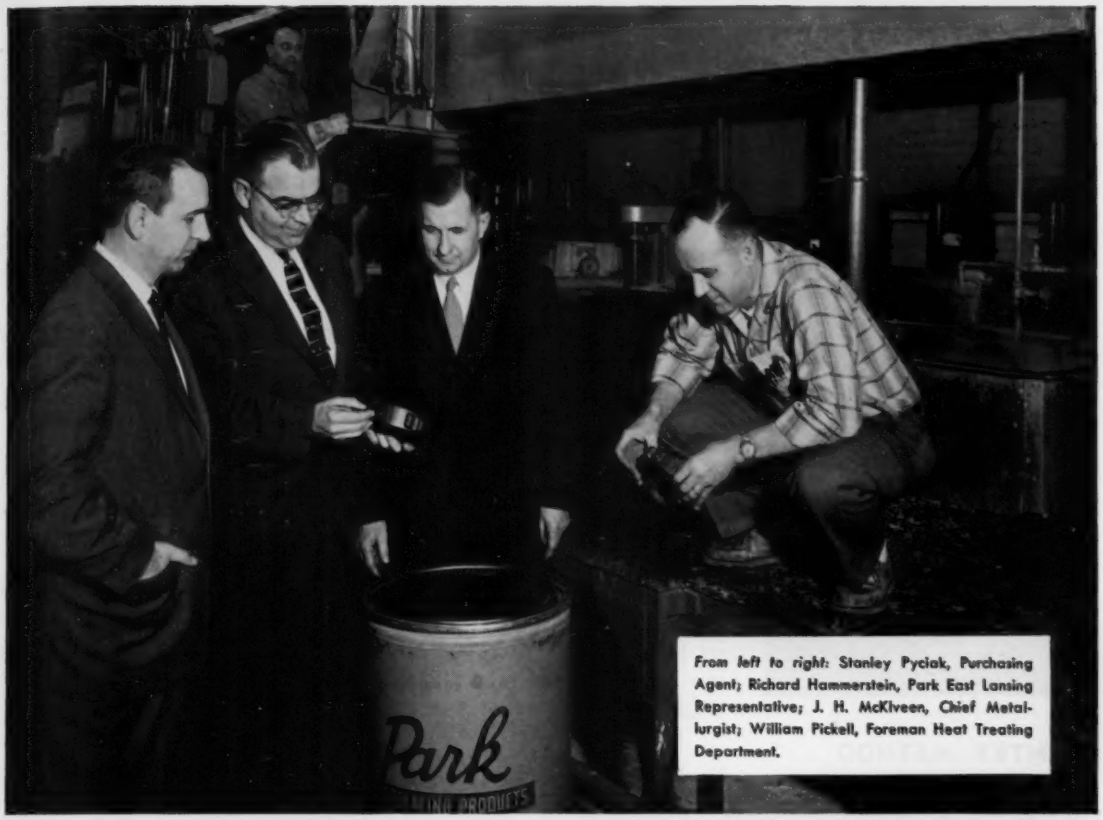


The gas-fired model is heated by immersion tube with eductor assuring quiet, efficient operation. Spray nozzles above and below the work are supplied by a powerful 240 GPM pump driven by 2 HP motor. The unit is supplied complete with magnetic starters, automatic temperature control, pilot safety device, and timer which automatically turns off the pump and lights a signal light at the completion of the cycle. The Waukee Washer can be supplied either electrically or steam heated as well as gas-fired.

For further information circle No. 5

HIGH CAPACITY VACUUM PUMPS

Mechanical Booster Vacuum Pumps introduced by the NRC Equipment Corporation, Newton, Massachusetts, are said to greatly reduce the time required for many industrial high vacuum processes. Available in six sizes from 1,000 to 12,000 cfm, these new multistage unit pumps operate at top capacity throughout the broad pressure range of 5 to 2200 microns, the



From left to right: Stanley Pyciak, Purchasing Agent; Richard Hammerstein, Park East Lansing Representative; J. H. McKlveen, Chief Metallurgist; William Pickell, Foreman Heat Treating Department.

"PARK'S NU-SAL and THERMO-QUENCH . . . give us excellent results . . . in austempering automatic transmission bands to exacting specifications."

J. H. McKlveen, Chief Metallurgist, Kelsey-Hayes Wheel Co., Jackson, Mich., says, "Our problem is one of supplying the heavy demands of the automobile industry for automatic transmission bands to their exacting specifications.

"We austenitize these bands at 1550-1600 degrees F. in Park Nu-Sal for seven to ten minutes depending on the thickness of the band. They are then quenched at 650 degrees F. in Park Thermo-Quench for seven minutes. These operations are followed by a cold water quench, hot water rinse, and a soluble oil bath for preservation until use.

"The reason we use Park Chemicals? Over a period of years, we've found Nu-Sal and Thermo-Quench meet our toughest requirements. When you are doing a high volume job, any stoppage is a major problem. Park chemicals have helped us reduce downtime—up production. And one other thing, you can't beat Park for service and delivery."

For complete data on Park Nu-Sal Neutral Salt write for technical bulletin H-2. For complete data on Park Thermo-Quench write for technical bulletin H-19. Park Chemical produces a complete line of heat treating and quenching materials and would be happy to help you work out a solution to your heat treating problems without obligation. Call or write today.

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Woodside Rapid Carburizers (Non-Burning—Charcoal–Coke–Specification) • Park-Kase Liquid Carburizers • Quenching and Tempering Oils • Cyanide Mixtures • Neutral Salt Baths • High Speed Steel Hardening Salts • Iso-Thermal Quenching and Tempering Salts • Protective Coatings (No-Carb—No-Kase—No-Scale—No-Tride) • Carbon Products (Charcoal–Crushed Coke-Pitch Coke–Lead Pot Carbon) • Kold Grip Polishing Wheel Cement • Par-Kem Metal Cleaners • Cutting and Grinding Compounds (Kem-Cut—Kem-Grind—Blue Ice)

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PRODUCTION TOOLING SIMPLIFIED AT EASTMAN KODAK COMPANY

"The Sentry Diamond Block Atmosphere Makes the Difference"

Sentry DIAMOND Block



QUALITY TOOL HARDENING REQUIRED

Sentry Furnaces have been used at Eastman Kodak to harden all types of special high speed steel for tools, such as the perforators and circular form tool blanks shown at the left.

Quality tools are essential for the economical production of Kodak's line of precision photographic equipment. Sentry Furnaces utilizing the simplified Diamond Block Atmosphere protect tool hardening quality, thereby promoting economy.

SENTRY METHOD EASY TO OPERATE

The Sentry Diamond Block Atmosphere is chemically constant and truly neutral, requiring no analysis or regulation. Because chemical and metallurgical problems are eliminated, the operator concerns himself solely with tool hardening production.

QUALITY RESULTS EVERY TIME

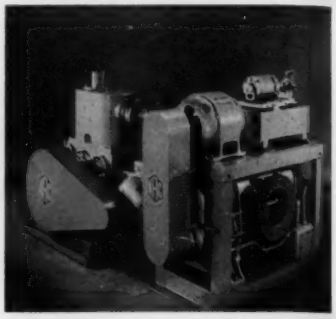
Sentry Furnaces harden all types of high speed steel tools completely free from scale and decarburization. Ample soak is permitted to assure full hardness, while sharp edges are maintained exactly as before hardening.

Ask for Catalog **M-53**



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TRADEMARK
ELECTRIC FURNACES
THE SENTRY CO.
FOXBORO, MASS.

range in which large amounts of gas are evolved in such varied operations as freeze-drying, vacuum



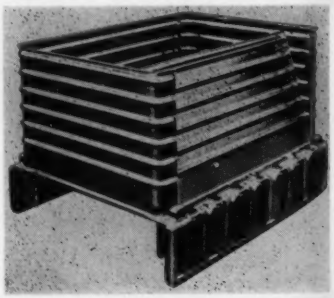
melting and heat treating, impregnation and dehydration and in which neither conventional mechanical pumps nor vapor (diffusion) pumps perform efficiently.

As illustrated, a conventional mechanical vacuum pump operates at full capacity at atmospheric pressure. As the system pressure is reduced, the volume of gas the pump displaces drops steadily. Oil booster and ejector pumps operate efficiently only over a very narrow pressure range.

For further information circle No. 6

MATERIALS HANDLING BOX

Eliminating up to 66 per cent of the space needed to store and ship empty boxes, a new "fold-away" materials handling box which can

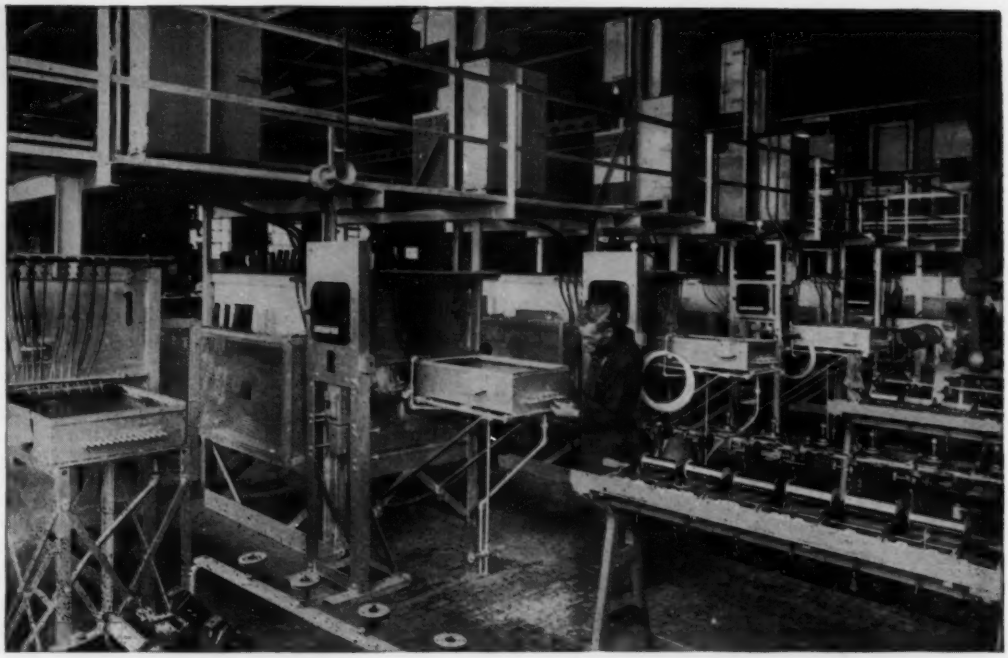


be reduced to 1/5 of its original size has been developed by the Pressed Steel Division of Republic Steel Corp., Cleveland, Ohio.

Made of corrugated steel, the box has collapsible sides which are easily set up or folded down.

For further information circle No. 7

(Continued on page 41)



Now Completely Equipped With "Hot Rods." Part of a battery of nine electric strand bright annealing furnaces at the Dunkirk, N. Y., plant of Allegheny Ludlum Steel Corporation. Wire is annealed in these furnaces in alloy tubes containing a dissociated ammonia atmosphere. Operating temperature averages 2200°F. Furnaces are shut down after a five- or six-day working week.

Why Allegheny Ludlum converted to "HOT RODS"

Leading steel manufacturer reports longer life, improved performance, with CRYSTOLON heating elements*

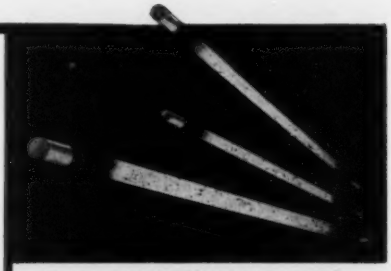
Allegheny Ludlum Steel Corporation hoped to improve the varying performance and service life of the heating elements originally installed in their electric wire-annealing furnaces.

So, they converted all nine furnaces completely to Norton "Hot Rods" — and got the improvements they wanted from the very start. For example, one set of "Hot Rods" was recently removed after 10,000 hours of trouble-free service.

Proved "Hot Rod" Advantages

Many plants report Norton CRYSTOLON heating elements outlast other non-metallic heating elements *up to 3 to 1!* This much longer life means savings in element costs, because fewer "Hot Rods" are needed. Also, you get reduced maintenance, due to less changing of elements or voltage taps. And "Hot Rods" help protect product quality because their slow, evenly matched rate of resistance increase means more uniform heating.

The big illustrated booklet, *Norton Heating Elements,* gives further facts on how "Hot Rods" can help improve your furnace operations and cut costs. For your copy write to NORTON COMPANY, Refractories Division, 624 New Bond Street, Worcester 6, Massachusetts.



Norton CRYSTOLON Heating Elements, or "Hot Rods," are a typical Norton Rx — an expertly engineered refractory prescription for greater efficiency and economy in electric kiln and furnace operation. Made of self-bonded silicon carbide, each rod has a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in standard sizes.

NORTON
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Engineered... Rx ...Prescribed
Making better products... to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Grinding Machines • Refractories
BEHR-MANNING PRODUCTS: Coated Abrasives Sharpening Stones • Behr-cat Tapes
*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

HARDNESS MEASUREMENT

(*Continued from page 27*)

shape is pressed into the material to be tested under a selected load, the load removed, the resulting impression measured and the hardness calculated by dividing the load by the surface area of the indentation. Loads up to 50 kg. are generally used and the indenter is a sharp-pointed square-base diamond pyramid having an included angle between opposite faces of 136 degrees.

The average length of the two diagonals is measured with a microscope and the hardness calculated from formulae or by reference to a table. This test is used for research work and on sections of odd shapes which have to be mounted in bakelite or clamped for testing.

Although the Scleroscope, Fig. 6, is a dynamic form of hardness tester it will be described here as it is oftentimes used for the testing of large work pieces, especially where the instrument must be brought to the work. Invented by A. F. Shore in 1907, it operates on the drop and rebound principle. A diamond-faced hammer is dropped within a glass tube on the surface of the specimen being tested. The height of rebound on an arbitrarily marked scale is an indication of the hardness.

Portable hardness testers are available in a variety of designs for use on different applications. Generally, these portable units are not as accurate as the

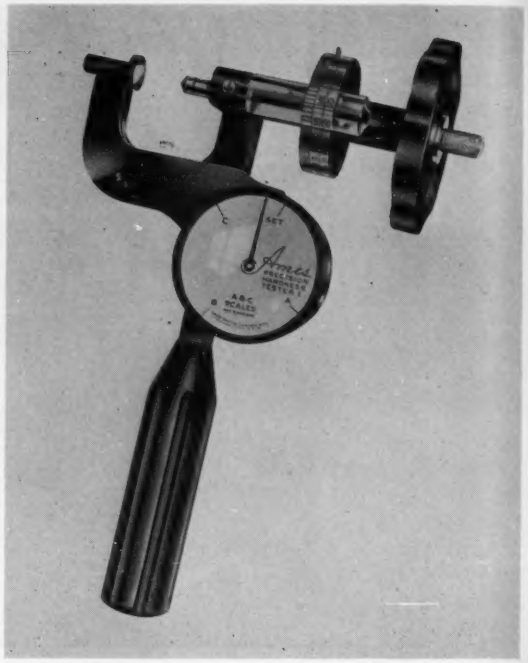


Fig. 7—This portable unit, the Ames Precision Hardness Tester, can be used to test work up to a given thickness. It tests a relatively short distance inward from the edge of the work. *Photo courtesy of Ames Precision Machine Works.*

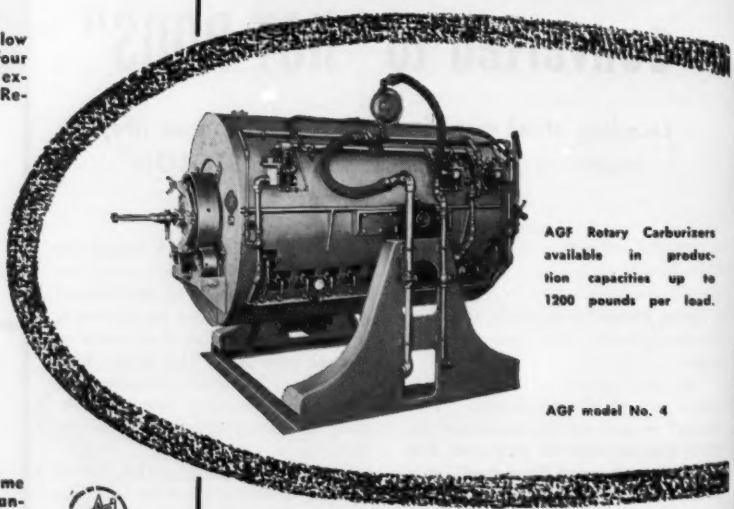
ELIMINATE "POINT OF CONTACT" CASE VARIATIONS

Gentle tumbling of the work pieces by slow retort rotation—one revolution every four minutes—assures uniform heating and exposure to the controlled atmosphere. Result: better products.

Your processing costs reduced because . . .

- **only necessary labor required during the charging and discharging operation. Large production lots quickly handled with mechanized tilting.**
- **only the work enters and leaves the furnace retort. Chains, conveyors, trays and other inefficient mechanisms are eliminated.**
- **alloy costs are decreased. The retort remains in the furnace at all times. Rotation and the use of an ample combustion chamber further assure maximum alloy life.**
- **AGF Carburizers are flexible. The same one can be used to clean harden, anneal, normalize, etc. a wide variety of work without modification.**

MIX THE WORK WITH AGF ROTARY GAS CARBURIZERS



AGF Rotary Carburizers available in production capacities up to 1200 pounds per load.

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"Pioneers since 1878"

conventional bench tester and will not give as accurate indication of hardness. However, if the part cannot be tested in a more accurate machine, due to its size and shape or conditions surrounding its location, then a test determined on a portable unit may be of considerable value.

Portable testers fall into two groups. One is of gooseneck design which takes work up to a given thickness and tests inward from the edge of the piece a relatively short distance. The Ames, Webster, King and Riehle testers are in this grouping. Fig. 7 illustrates the Ames tester and Fig. 8 shows the Riehle unit.

The second category consists of machines which measure hardness in the center of large sheets and bulky pieces. The Barcol Impressor, Fig. 9, the Poldi and Ernst are typical of this class. No one portable tester is designed to meet all the requirments referred to above.

The file test may be considered along with portable testers. The surface being tested is rubbed slowly but firmly with the sharp teeth of the file until it is determined whether or not the teeth will bite. This test is generally limited to untempered hardened parts or for exploring surfaces for decarburization. In an effort to rehabilitate blind persons, the Timken Roller Bearing Co. checks the hardness of roller bearing races with blind workers who can detect, through sound and feel, whether the file will bite or slide over the surface.

Many factors determine the indentation hardness of metallic materials. Assuming the mechanical requirements of the machine and indenter to be realized through use of proper equipment, the operational factors are:

1. Normality of test surface to load. For most work, angles less than about 5 degrees will not affect the results.
2. The material must not rock or slip under the application of the testing load.
3. The time the specimen is under full load.
4. Rate of load application.
5. Spacing of the indentations. They must not be too close to each other or to the edge of the specimen.
6. The specimen must be homogeneous unless the test is being made to determine decarburization, segregation or inclusions. The grain size must bear proper relation to size of the impression.
7. The surface conditions must be such that work hardening is not introduced in preparing the sample for test.

Hardened and Tempered Steel

Probably the greatest single use to which the hardness test is put is in testing steel that has been hardened, heat-treated and tempered. For this purpose the C scale of the Rockwell tester is generally used, although in the laboratory the use of the 136°



Pangborn Hydro-Finish cut cleaning time 50% in this plant

Paid for itself in only six months

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This year's award shall be presented at the 1957 Annual Meeting of the Institute, and all Articles appearing in any issue of METAL TREATING from September-October 1956 to July-August 1957 or any Lectures presented at the 1956 Annual and 1957 Spring Meetings are eligible for consideration.

Award Committee—

H. N. Bosworth, *President, Metal Treating Institute*

H. C. Knerr, *Chairman, Publication Committee*

L. G. Field, Fred Heinzelman, Jr., N. R. Hodgson, K. U. Jenks, Michael Kober, C. R. Weir; *members, Publication Committee*

C. E. Herington, *Editor, METAL TREATING*

diamond pyramid test is common for research and development work.

It is well known that when carbon steel is heated to a high temperature and is cooled very rapidly it becomes hard. By the same token, if it is cooled slowly, it becomes soft. If the previously hardened



Fig. 8—Another portable unit, the Riehle Hardness Tester, can also be utilized to test work up to a given thickness at relatively short distances from the edge of the work. *Photo courtesy of Riehle Testing Machines.*

material is reheated at relatively low temperatures, it is possible to impart to the steel any desired hardness over a wide range of values.

Carbon is the most influential element in steel in determining the hardness obtainable in the hardening process. Fig. 10 shows the maximum hardness vs. carbon content in carbon steels. These are the results obtained with the most rapid quenching, as in water. The hardness test may thus be used to

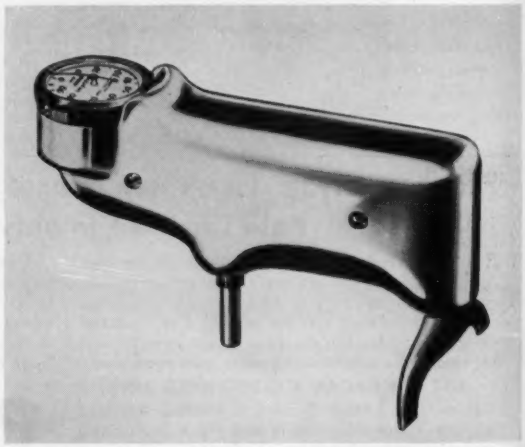


Fig. 9—This portable hardness tester, the Barcol Impressor, can be utilized to measure the hardness in the center of large sheets and bulky work pieces. *Photo courtesy of Barber-Colman Company.*

determine whether optimum hardness has been obtained from a steel with a given carbon content. However, it may not be desirable to use the steel in the maximum hardness "as-quenched" condition. By tempering the steel, other desirable properties may be obtained, though at the expense of hardness. This applies to all plain carbon and most of the other commonly used steels.

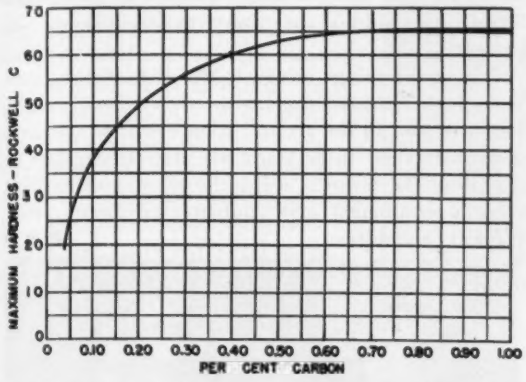


Fig. 10—Maximum hardness versus carbon content. *Photo courtesy of Reinhold Publishing Corp.*

Fig. 11 shows the Rockwell C scale hardness of 45 carbon steel when tempered at different degrees of heat. Similar curves of hardness vs. temperature are available for all commercial steels. If a plain-carbon steel of sufficient mass is quenched in a medium which produces a less drastic quench than water, as in the case of oil, the hardness is much less. In the case of the 45 carbon steel, it would be about Rockwell C30.

Thus, in a plain-carbon steel the hardness test is extremely valuable in measuring and differentiating the hardness after heating and quenching in different media and after tempering at different temperatures.

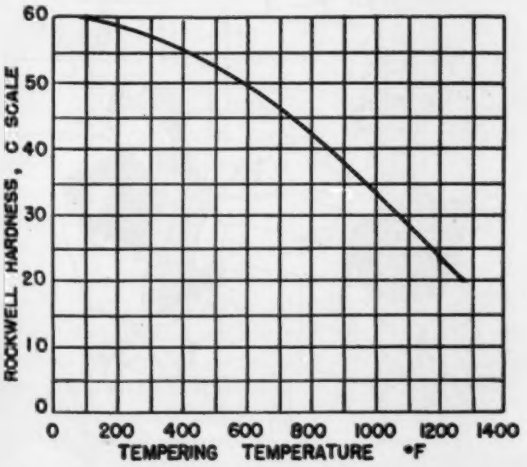


Fig. 11—Hardness versus tempering temperature for 45 carbon steel. *Photo courtesy of Reinhold Publishing Corp.*

(Continued on page 42)

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2. Gogan Tester, Brinell, Model 1618-2, Serial #5250-5, 10" throat.
3. Barkling Hi-speed furnace gas fired, Serial #3117, Opening 6" by 8½"; no instruments; good condition.
4. Pittsburgh Instrument and Machine, Brinell test machine, Serial #1118.
5. Cyanide furnace with salt pot; Standard American make—1948. Pot size 24" by 20" equipped with blower, valves, ventilating hood with stack 18" dia. 18 ft. high with Brown indicating control instrument.
6. Flexible mechanical power press 8 ton; make—general; Type #83; Serial #2090, 9" stroke; good condition.
7. Wheelabrator Tumblast; size 36" by 42"; Serial #A48990; make, American Wheelabrator; complete with or without dust collector.
8. Hydroscale for crane or hoist; Model #CH705-30; capacity: 15,000 lbs.; dial diameter 30"; excellent condition, used only 1 month.
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M.T.I. *Activities*

HEINZELMAN'S 40th ANNIVERSARY

Fred Heinzelman & Sons of New York City are celebrating their 40th year of operation as a commercial heat treating plant, and the story of the company's birth, growth, and development reflects the amazing growth and development of the heat treating industry throughout the entire United States and merits a brief account here in these pages.

A Swiss by birth, Fred Heinzelman, Sr. followed the footsteps of generations of ancestors who were blacksmiths. During his early apprentice days under his father's instructions, he became skilled as a farm implement and ornamental blacksmith. It was during this period that the first rudimentary lessons in the art of heat treating were acquired. In subsequent years he practiced his trade while traveling throughout Italy, Germany, and Paris where he worked in the Renault Company as heat-treater and hardener.

In 1909 Mr. Heinzelman came to the United States to seek his fortune as so many other Europeans were doing at that time. For the next eight years he worked as a heat treater and hardener for such large industrial firms as the Richmond Locomotive Works of Richmond, Virginia; the E. W. Bliss Company; and the Eiseman Magneto Corp., of Brooklyn, New York.

In 1917, he opened his own commercial hardening plant—(a term since replaced by commercial heat treating)—under the name Precision Hardening Specialties Co. at 498 Broome Street in New York City. At this time there were no commercial heat treaters in the city, and by this term it was meant that there were no craftsmen who accepted a variety of heat treating and hardening jobs of varying sizes on special order from outside concerns. Thus he became "the first commercial hardener in New York City."* Progressively the name of the company was changed to Heinzelman Heat Treating and Hardening Works, and finally to Fred Heinzelman & Sons.

Based on his philosophy of trying to do some one thing better than anyone else can do it, his business was successful and the company had to move in 1927 to larger quarters at 154 Spring Street. As Mr. Heinzelman explains it: "The heat treater who is to succeed must live up to the ideal of trying to do the work better than anyone else regardless of the time or expense involved. It is my policy that only the best is economical, and, therefore, I take advantage of every new and useful idea in order to achieve successful results." In 1938, expanding business again forced them to move to larger quarters at 138 Spring Street, the address they have maintained to the present.

One of the things in which Mr. Heinzelman takes great pride is the fact that he has educated and trained his three sons in the art and science of heat treating. They with their sister Marie are actively engaged in operating the business using the most modern heat treating equipment and applying the latest metallurgical procedures. ■ ■ ■

* As far as all avilable records show.



Mr. Fred Heinzelman, Sr. (left) is shown here receiving his certificate of an Honorary Life Membership in the Metal Treating Institute during the 1955 Annual Meeting in Philadelphia. The certificate is being presented by the President of the MTI at that time, Mr. Clifford M. Cook.



"YOU, DOWN STAIRS!... STOP FOOLING AROUND WITH METAL TREATING!... SEND THE WORK OUT!"

NEWS TO HEAT TREATERS

(Continued from page 34)

NEW VAPOR DEGREASER

In answer to the need for a larger work area in degreasers, Baron Industries, Los Angeles, Calif., has just extended the Baronet Series to include two rectangular shaped vapor spray degreasers for larger sized parts and heavier work loads.

These compact degreasing machines are fabricated of 12 gauge and 3/16" plate for longer life, and are protected against corrosion with a fused phenolic interior coating. These new models have such heavy-duty features as a full water jacket, offset coil condenser and complete manual spray equipment.

Available in two sizes, these new Baronets have unobstructed working dimensions of either 36" or 48" in length, width 18" and vapor depth 24".



As little as twelve gallons of solvent is required for operation and considerable savings can be realized by the degreaser's reclaiming feature. When the solvent becomes dirty, it can be automatically reclaimed within the machine for further use.

Immediate delivery can be made in gas, steam, or electrically heated models. The units are shipped assembled and wired, complete with switches, work rest, special leak proof pump and motor, solvent resistant spray hose, aluminum spray lance and special slide-off lid.

For further information circle No. 8

(Continued on page 48)

THIS CAN'T HAPPEN
TO AN ECLIPSE PRESSED STEEL POT



Immediate delivery from stock on 78 standard pots.



...yet they actually cost less than cast or alloy pots!

Sudden failure of the cast pot shown above flooded the furnace and caused costly damages to brickwork, burners, and controls — a familiar story to some users of cast pots. But did you know that pots are now available which cannot possibly have stresses, cracks, or other critical areas to cause such failure? You *cannot buy* a defective pressed steel pot! No defective steel will survive the stresses of drawing. This means that with pressed steel pots visual inspection is completely reliable. And, since Eclipse Pressed Steel Pots actually cost only one-third as much as cast pots, you replace these low-cost pots *before* they can fail and ruin your furnace. Scheduled preventive maintenance puts your business on a no-gamble, high-profit basis. Their perfectly uniform 3/8 in. section and the high thermal conductivity of firebox quality open-hearth mild steel mean faster, more uniform heating, more production in less time with substantially less fuel. Insure your profits on lead, salt, cyanide, oil tempering, and metal melting with Eclipse Pressed Steel Pots!

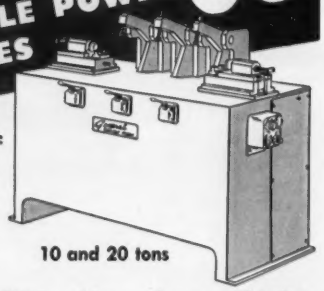
Write today for illustrated catalog and price list . . . details and dimensions of standard pots . . . facts about Eclipse Metalized Pots for maximum protection from corrosive action of hot gases in high-temperature heat-treating. Metalizing can triple pot life.



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About Hardness Testing



Everything you need to know about hardness testing is told in this handsome book, prepared by the makers of the internationally respected CLARK Hardness Testers for "Rockwell Testing." Simple, easy-to-read text (in English) and numerous illustrations show the equipment and procedure for fast, accurate hardness testing of ferrous and non-ferrous materials. If you would like a copy, *free of charge*, just attach this ad to your letterhead or write "Send book." A copy will be mailed to you promptly.

P.S. If you are interested in descriptions and prices for CLARK Hardness Testers (Standard and Superficial) of *guaranteed accuracy*, say the word and we'll gladly supply them.

CLARK INSTRUMENT INC.
10203 Ford Road • Dearborn, Mich., U.S.A.

HARDNESS MEASUREMENT

(Continued from page 39)

But there are many limitations to the use of plain-carbon steels. They are often alloyed with commonly used metals such as nickel, chromium, tungsten, vanadium, manganese and molybdenum. In the use of these alloy steels, the hardness test is extremely important.

Basically, the purpose of alloying steel is to impart certain properties which plain-carbon steel does not have. Carbon steels are usually quenched in water for hardening and usually harden to a depth 1/16 to ⅛ inch, depending on the thickness. Underneath this hardened layer will be a soft, yet tough core. Alloying the steel maintains the surface hardness and also carries the hardness to a much greater depth than for a plain-carbon steel. This is very important when work of large dimensions is hardened, as the depth of hardening is influenced by the size of the specimen. The degree of depth of hardening produced is not the same for all alloying elements, and the hardness test is used among other things to determine the depth hardness characteristics, generally referred to as "hardenability." It may be defined as the capacity of the steel to harden by quenching.

For years metallurgists have been devising special tests for measuring the hardenability of steel. Rapid advances have been made since 1928 when the Jominy end-quench test was introduced. This is a simple and useful test, which permits hardenability data to be obtained over a wide range of sizes and also permits these data from various sources to be interchangeable. It is not generally suited for shallow hardening steels, but is admirably suited to alloy steels except those to be heat-treated in very heavy sections.

From the hardenability test much valuable data is obtained and under certain conditions it may be

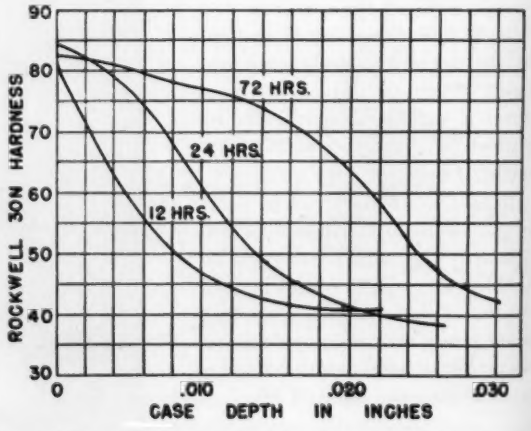


Fig. 12—Depth hardness characteristics of steel nitrided at constant temperature for 12, 24 and 72 hours. *Photo courtesy of Reinhold Publishing Corp.*

more useful than chemical analysis. It has proved to be of great value when medium-carbon alloy steels are considered. In such cases, one alloy steel may be substituted for another, provided the two steels have equally good hardenability. The following information may be obtained from the hardenability test:

1. Maximum hardness at a cooling rate of about 600°F. per second.
2. Depth of hardness.
3. Effect of size or mass.

Hardenability values may also be determined for cast steels and thus an idea of the depth of section to which cast steel will harden will be obtained.

Everyday Problems of Hardness Testing

Just how does the foregoing tie in with everyday problems of hardness testing? Enough has been given to show that the hardness test may be used to determine differences in heat treatment of different steels. Experience has shown that, generally speaking, increasing the hardness increases the wear. Thus, it is possible to specify definite hardness values for different tools, dies and other heat-treated parts.

Certain types of tools, such as blacksmith's tools, hammer dies and the like, may have comparatively low hardness values, whereas razors, engraving tools, scribers, etc., have very high values. In automotive work, parts which have been hardened and tempered require hardness inspection. This testing provides a check on the best treatment to make certain that specifications have been met. Thus failure of the part in service is prevented. Sufficient inspection should be made to prevent the possibility of improperly heat-treated parts finding their way into final assembly. King pins, valve tappets, gears and camshafts are among the parts requiring 100 per cent quality control inspection for proper hardness.

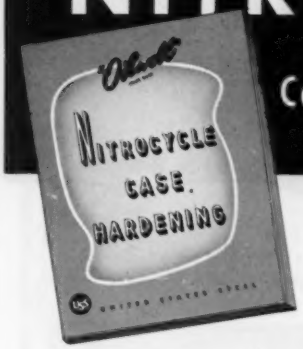
Case-Hardened Steels

Hardness tests are very important in testing the hardness of case-hardened steels, as they provide information concerning the hardness and depth of penetration of the case.

In testing case-hardened material, it is essential that the depth of the case be sufficient to support the penetrator properly. The case depth should be at least 10 times the depth of indentation. As the depth of indentation of a Rockwell C63 value is less than 0.003 inches, it is necessary that the case depth be at about 0.030 inches if a true Rockwell C scale reading is to be obtained.

A low reading might indicate a soft surface or a shallow case depth. This feature is often used to advantage in controlling depth of the case. A Rockwell A scale test is first made, followed by a C scale test. If the C scale test is lower than the A scale value, when converted to the C scale, it is safe to assume that the surface hardness is correct, but that the C

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scale is in error due to insufficient depth of case. Correlations may thus be established for controlling the depth of case by the C scale value. Such control should be augmented by careful supervision of the chemistry of steel and by accurate heat-treating in the case-hardening process.

Hardness penetration of the case may be studied by taper-grinding the sample with a slope of from 10 to 1 or 20 to 1. The test is then made on the surface below the original unground surface. Incidentally, the hardness of the core may be tested by grinding a depression in the piece depending upon the case depth, and measuring the hardness at the bottom of the depression.

Decarburization

Decarburization caused by the loss of carbon from the surface of steel during heating for forgings, annealing or hardening may be determined by the hardness test. It is important to detect and prevent decarburization, as it results in the loss of wear resistance at the surface.

The test usually used for decarburization in heat-treated steel involves two determinations, one with the 15N scale of the Rockwell superficial test and the other with the C scale of the normal Rockwell test. If the equivalent Rockwell hardness is not obtained by converting from the 15N scale to the C scale, a soft decarburized surface may be present. Decarburized surfaces 0.004 inches or deeper may be detected in this manner. The 136° diamond pyramid test may be used, as well as the microhardness test on this decarburized surface, to determine the hardened case depths.

Nitrided and Thin Case-Hardened Surfaces

If a core is hard, but only 0.005 to 0.010 inches thick, it must be tested by either the Rockwell superficial method, or the 136° diamond pyramid test. Fig. 12 shows the depth-hardness characteristics of such hard, thin cases after surface grinding. The samples were nitrided at constant temperatures for 12, 24 and 72 hrs. These curves clearly show the different hardness gradations caused by various periods in the nitriding process. It will be observed that with tests at a depth of 0.010 inch, hardness values for the sample nitrided for 12 hrs. are practically the same as those for the core. For the samples nitrided 72 hrs., there is a considerable increase in hardness.

Surface hardness less than 0.005 inches generally cannot be determined by the depth-measurement method. The Vickers tester with a load of 1 to 5kg. or the Wilson Tukon tester, Fig. 13, is used for measuring the hardness of such thin cases. Where cases are in the neighborhood of 0.001 to 0.002 inches, the microhardness tester is necessary.

Forgings are generally tested by the Brinell method. The large impression of the Brinell test is of distinct

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advantage because it results in an integrated value instead of a very local value as in the case of the Rockwell test.

Hence, a very close relation exists between Brinell hardness and the tensile strength of forgings. Surface conditions such as decarburization, which are frequently not detrimental, do not appreciably affect the Brinell number.

Cast Iron

Cast iron is generally tested by the Brinell method, but the application is not as complete as in the case of forgings. The larger indentation is an advantage because the material is not uniform. Any surface conditions, insofar as hardness is concerned, will be minimized by the deep penetration. In cast iron, a good relationship exists between tensile strength and Brinell hardness values.

The Rockwell tester is used in testing cast iron, especially in small sections, where there is insufficient area for the Brinell method. The B scale is sometimes used but the E or K scale is preferable. Very good Rockwell results are obtained using the E scale by removing sufficient metal from the surface of the sample.

Hard white iron castings are generally tested on the C scale of the Rockwell tester, or by the 136° diamond pyramid method. If the material is not homogeneous, several readings should be taken and averaged.

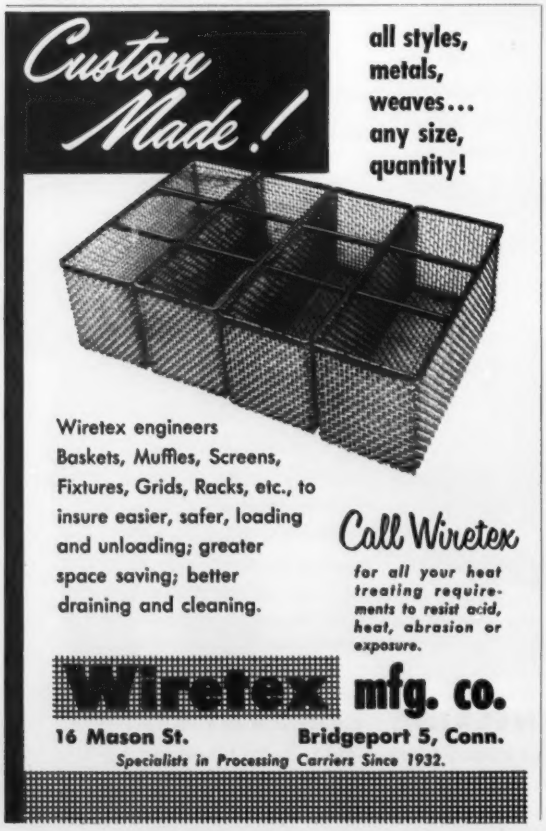


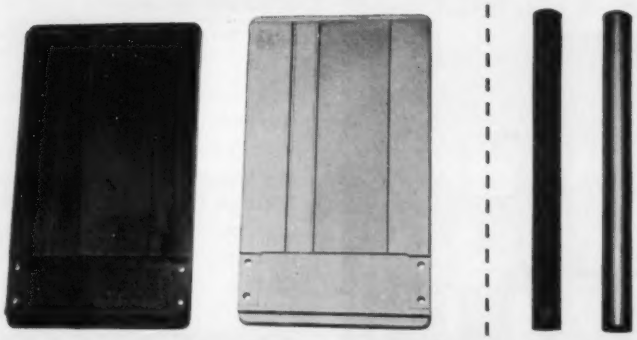


Fig. 13—This microhardness tester, the Wilson Tukon, Model LR, is generally utilized for measuring the hardness of thin cases in the neighborhood of 0.001 to 0.002 inches. This unit can also be used for macro-hardness testing. *Photo courtesy of Wilson Mechanical Instrument Division, American Chain & Cable Company, Inc.*

Conclusions

In closing it should be emphasized that the hardness test provides a quick and inexpensive means of quality control for the heat-treater insofar as hardness is related to quality. To get the best results, the limits must be properly set and precautions must be taken to void the pitfalls encountered when testing thin materials and cylindrical parts. Hardness conversion must be resorted to only as a guide and never be used to set specifications, unless the limits are exceptionally wide.

Proper use and interpretation of quality control methods will materially reduce the cost of inspection and insure uniformity in hardness. The tool engineer can be of tremendous assistance in hardness testing by arranging for the proper handling of the work to and from the operator, and providing the proper tools for supporting the work which is being tested. ■■■



STEELETTS® clean toughest heat treat scale

cut abrasive consumption 73.8%

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Mr. Anthony J. Beck, Plant Engineer, points out the first consideration of a job plant must be finish, because customers demand thorough cleaning and uniformity of finish from batch to batch. Steeletts scored high on this count and gave improved speed, too. But in addition to these advantages, Steeletts outlasted chilled iron 4 to 1 in tests conducted in the same blast cleaning machine on the same type of work. Grit consumption was cut 73.8%, and Mr. Beck pointed out, "We find that when a grit has a longer life, equipment maintenance savings are greater than the savings we make in grit costs."

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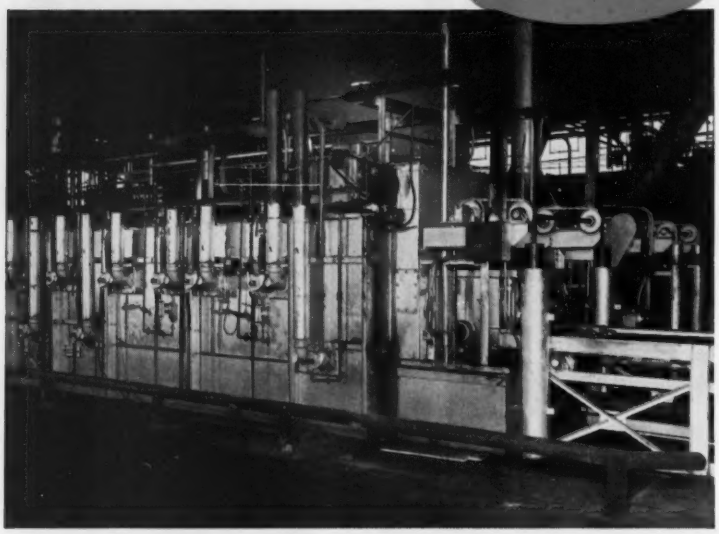
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LET'S TALK ABOUT

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High production demands can be met only when every piece of equipment in the plant is geared to its job. In many plants, the bottleneck is heat treating because furnaces which were modern five years ago are virtually obsolete. These units must be replaced, redesigned, or added to.

Automatic handling of materials is one answer, of course. Today, some heat treating systems are tied right into production lines. In other plants, work is centralized with automated equipment eliminating most stock handling. A single operator loads green work and removes finished parts.

Some furnaces accomplish dual jobs. A recent Holcroft installation was built to temper two entirely different classes of carburized parts. The furnace was designed with a double chamber with each side operating at the required temperature. Flags, placed on the trays requiring low temperature tempering, keyed the line so that the work automatically positioned itself in front of the correct chamber. Another installation featured a double deck furnace—designed so that two entirely different heat treat processes were accomplished in space where but a single furnace would normally go.

And so it goes: a little idea to save a minute or to eliminate a manual operation—a brainstorm that combines two or more furnaces or steps up furnace capacity. This Holcroft concept can help you produce more for less and with better quality. Better write today.

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NEWS TO HEAT TREATERS

(*Continued from page 41*)

2ND WORLD METALLURGICAL CONGRESS

A member of the American Academy of Science and a former Vice President of the General Electric Company has been appointed Director General of the forthcoming Second World Metallurgical Congress which will be staged in Chicago next November 2 to 8. He is Dr. Zay Jeffries, Pittsfield, Mass., one of the nation's outstanding metal scientists and a former president of the American Society for Metals which is sponsoring the world conclave on metals and metal resources of the free world.

NEW MANAGER

The management of The Gas Machinery Company, Cleveland, Ohio, has announced the appointment of James E. Hovis as Manager of the Industrial Furnace Division.



Hovis previously managed sales engineering for steel mill furnaces. In his new position, Hovis will direct engineering, manufacturing, and installation of all Gasmaco furnaces—which include large rotary hearth, tube normalizing, continuous pusher-type, roller hearth heat treat, continuous strip annealing, high speed heating, continuous and batch-type annealing and continuous wire patenting furnaces.

For further information Circle No. 9

LETTERS TO THE EDITOR

Dear Sirs:

We would like to be put on the mailing list for your excellent publication METAL TREATING.

A copy is now being received by our Heat Treat Department. They refer to the magazine quite frequently for trouble shooting and educational purposes. We would also like to receive a copy for our file. We find that your magazine is "tops" as far as common sense in heat treat metallurgy is concerned. Thank you for an anticipated kind service.

M. KAWAGUCHI
Metallurgist
Westinghouse Electric Corporation
Sunnyvale Mfg. Division
Sunnyvale, Calif.

Gentlemen:

The articles on "Straightening" which have appeared in past issues of "The Apprentice Corner" column in METAL TREATING have been of interest to us and we would like to incorporate them in our reference file. We find, however, that we do not have the first article of this series which appeared in the September-October issue and wonder if there is a possibility of our obtaining one or two reprints of that article.

WILLIAM S. ROBERTSON
Sales Manager
The Sentry Company
Foxboro, Mass.

Dear Sir:

I have read copies of your magazine. It appears to be of excellent quality and content. Since I am teaching a course in the Heat Treatment of Metals, I would like to subscribe to your magazine.

DONALD L. MYKKANEN
Assistant in
Mechanical Engineering
University of Illinois
Urbana, Ill.

Gentlemen:

Our Metallurgist, Mr. Robert Wawrousek, has requested that we contact you relative to being placed on your list of subscribers.

It is his understanding, that the subscription is free to eligible individuals in companies whose production facilities include the treating of metals.

If this information is correct, we will appreciate it if you will enter his subscription.

M. O. WERNER
Parish Pressed Steel
Division of Dana Corp.
Reading, Pa.

Dear Editor:

I would appreciate having my named added to your mailing list. I recall in another location of periodically receiving METAL TREATING.

In my present capacity as District Industrial Heating Specialist with the General Electric Company in their Cincinnati Office, such information as you send out may well be mutually beneficial.

R. E. WRIGHT
District Industrial Heating Specialist
General Electric Company
Cincinnati, Ohio

New Design



General Alloys' Cast-Wrought Pot gives extra long service life

This new solution pot combines a cast bottom with wrought sides, thus obtaining the best features of each for maximum pot life. In addition, these pots can be delivered quickly and at relatively low cost.

The cast bottom is uniform throughout and its superior strength prevents sagging and deformation of the pot during use. Careful fabrication, inert gas shielded welds, and complete X-ray testing assure 100% perfect construction.

General Alloys' Cast-Bottom Wrought-Side Pots are available in any size or shape . . . in any heat or corrosion resistant metal in thicknesses from 3/16" up to 1" or more.

Backed by 37 years of experience in making solution pots, this new General Alloys' design will give you long life and cut heat treating costs.

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Specialists in high alloy castings and fabrications for 37 years

MANUFACTURERS' LITERATURE

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FIELD-ERECTED FURNACES

A four-page bulletin covering modern, large size, Field-erected Production Furnaces for all forms of metal heat treating, and also for continuous enameling, aluminum melting and ceramic requirements is available from Lindberg Industrial Corp., Chicago, Ill.

For further information circle No. 10

RUST PREVENTIVE

The Flood Company, Hudson, Ohio, has published a new eight-page booklet covering its product, Penetrol.

The booklet explains in detail how and why Penetrol is so effective as a rust preventive, pain extender, and reinforcing paint additive. It is profusely illustrated.

For further information circle No. 11

"WHAT IS A FORGING?"

An 8-page booklet entitled "What Is a Forging?" is available from the Drop Forging Association.

Condensed and in non-technical terms for easy and understandable reading, the booklet describes how forgings are made and the many uses to which forgings are put. Also shown and described is how the age-old process of pounding metal into shapes by hand has progressed by use of modern machines to shape the metal for all types of products.

For further information circle No. 12

ABRASIVE SELECTION GUIDE

Pangborn Corporation, Hagerstown, Md., manufacturers of blast cleaning and dust control equipment has issued a new 12-page illustrated manual on the full spectrum of blast cleaning abrasives—their characteristics, application and selection. The work details methods for improving cleaning quality and cutting production costs in foundry, descaling, mold and die, shop maintenance, decorating and carving, part reclamation and finishing operations.

For further information circle No. 13

WASHING COMPOUNDS

Magnus Chemical Company, Inc., Garwood, N. J., has published a bulletin announcing the development of three new "non-foaming" spray washing compounds for hard, medium and soft metals.

This new line of spray washing compounds contains a non-foaming wetting agent that allows for maximum wetting of dirt deposits without the troublesome build-up of foam. With these new products, there is no restriction as to the

(Continued on page 53)

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Light metal alloy aging and solution heat treating ovens.

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Write for Bulletin 157.

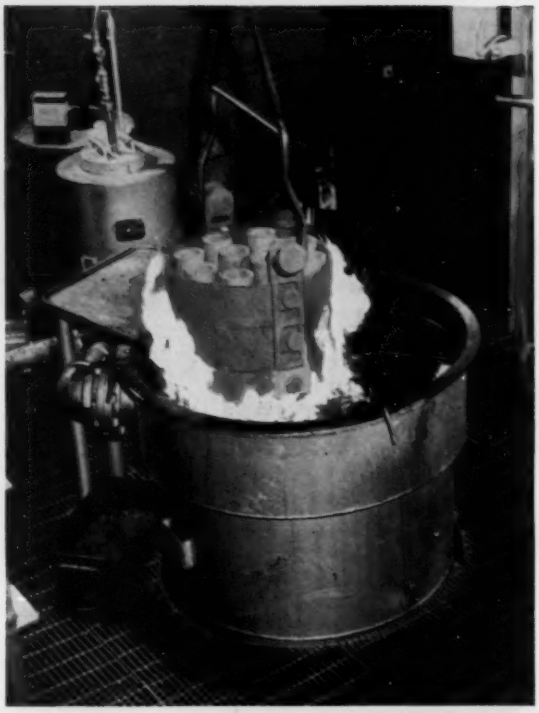
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Repeatedly heated to 1830°F...



Repeatedly cooled to quench temperature...

Inconel alloy stack-type trays look "good-as-new" at 2000-hour mark

These lightweight Wiretex-made fixtures also push treating costs down 20% in same period

These pictures make it clear.

After 2000 hours of pit-type heat-treating service, these Inconel* nickel-chromium alloy trays fabricated by Wiretex for Fenn Mfg. Co., Newington, Conn., manufacturers of rolling mills and swagers, are practically undamaged.

No serious attack from high heat. From thermal shock. From furnace atmospheres. From oxidation. From heavy loading. From quenching or degreasing media.

No serious effect, either, from the tempering, and – 120°F deep-freeze operations through which these same trays must often go.

Strength, fabricability of Inconel alloy opens way to new operating economies

Wiretex Mfg. Co., Inc., Bridgeport, Conn., has used the excellent strength and fabricability of wrought Inconel alloy to design into these trays features that cut Fenn's heat-treating costs some 20%. These include:

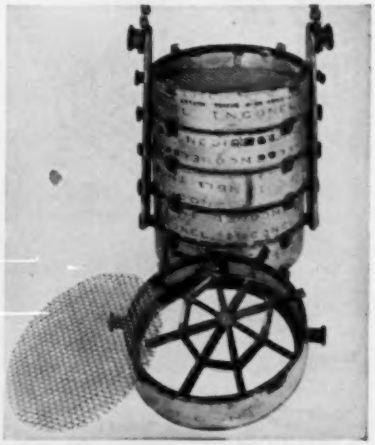
(1) A reduction in fixture weight that cuts heating time approximately 25%.

(2) An increase in allowable work load per tray over former trays of 30%.

(3) Improved stacking and lifting configurations speed materials handling.

The use of easily weldable Inconel alloy also improves repairability of the equipment, extends its life expectancy. There are two good ways to get the word about Inconel alloy fixtures: Your fabricator is one. The other is to write for the Inco bulletin, "Keeping Costs Down When Temperatures Go Up." *Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.



"This shows you tray design. Walls are solid Inconel alloy rolled and welded. Removable Inconel alloy grid and woven screen rest on shoulder."

Inconel ...*for long life at high temperatures* INCO TRADE MARK **Nickel Alloys**

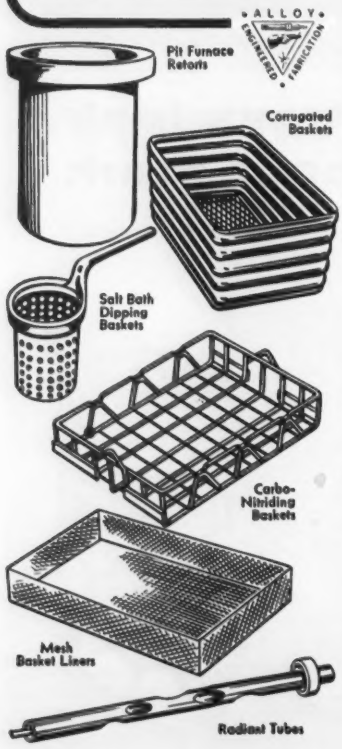
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MANUFACTURERS' LITERATURE

(Continued from page 50)

concentration used to obtain the cleaning result desired. Regardless of concentration and high temperature, solution will not foam.

Magnus "X-3" compounds are said to have unmatched cleaning ability because they are fortified with higher concentrations of wetting agent. Their built-in hard water control prevents scale formation, the free-rinsing properties leave surfaces water-break free and their cleaning action guarantees cleaner work.

For further information circle No. 14

PORTABLE POTENTIOMETER INDICATOR

A bulletin on their portable pyrometer indicator, the "MiniMite", has been published by the Thermo Electric Co., Inc., Saddle Brook, N. J. The "MiniMite" scale is over 23" long. This extremely small instrument weighs under four lbs. and measures approximately 4" x 5" x 6". Designed as a dual purpose instrument, it can be used (1) to measure temperature directly when connected to a thermocouple, and (2) as a standard comparison instrument against which to check other millivoltmeter and potentiometer-type instruments. Accuracy of this precision, null-balance indicator is ¼ of 1% of scale range. The bulletin contains complete information on specifications, calibrations and the 15 standard, double-range scales available with the "MiniMite."

For further information circle No. 15

RHEOSTATS FOR ELECTROPLATING

An illustrated four-page bulletin on the new H-VW-M universal carbon pile tank rheostats for electroplating is available from the Hanson-Van Winkle-Munning Company, Matawan, N. J.

The bulletin describes the advantages of the tank type of rheostat, which provides all tank voltages for specified line voltage and maximum amperage conditions. A standard rating chart is provided, together with instructions on how to select the proper H-VW-M carbon pile tank rheostat.

Four close-up photographs show sectional and front and rear views of the control panel, and a wiring diagram is included. Dimensions of the four sizes of H-VW-M carbon pile tank rheostats are given, together with the shipping weights. The bulletin contains complete mounting and operating instructions.

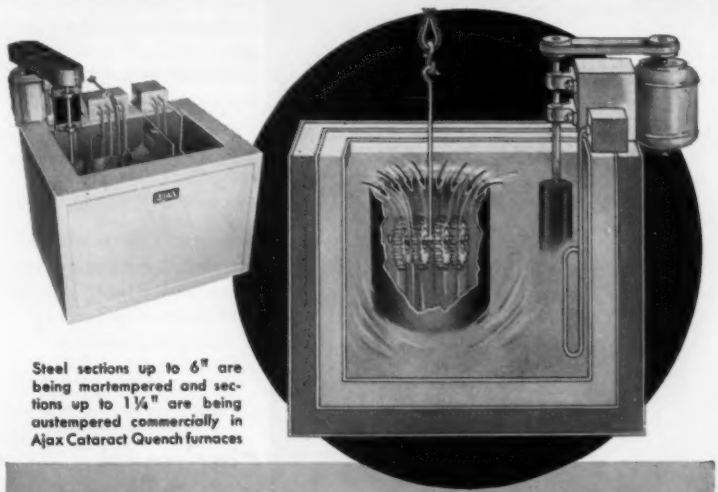
For further information circle No. 16

ARTICLES ON HEAT TREATING

O. E. Cullen, Chief Metallurgist, Surface Combustion Corporation, Toledo, Ohio, discusses "Basic Principles of Quality Gas Carburizing" in a new issue of their house organ *Heat Treat Review*.

Other articles in this issue are on Annealing and Age Hardening of Copper Alloy Coils, Low Cost Dew Point Control and TV Controlled Slab Furnaces.

For further information circle No. 17



Steel sections up to 6" are being martempered and sections up to 1¼" are being austempered commercially in Ajax Cataract Quench furnaces

A BIG STEP AHEAD IN ISOTHERMAL QUENCHING

AJAX HULTGREN Salt Bath CATARACT® QUENCH Furnace

WRITE for Ajax Martempering and Austempering case history bulletins.

...even for steel shapes and sizes that couldn't be austempered or martempered satisfactorily before

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These include more uniform hardness; so little distortion that parts can usually be finish machined *before* hardening; elimination of quench cracks; and increased toughness and ductility. Also, like all salt baths, Ajax Cataract Quench Furnaces are readily mechanized.

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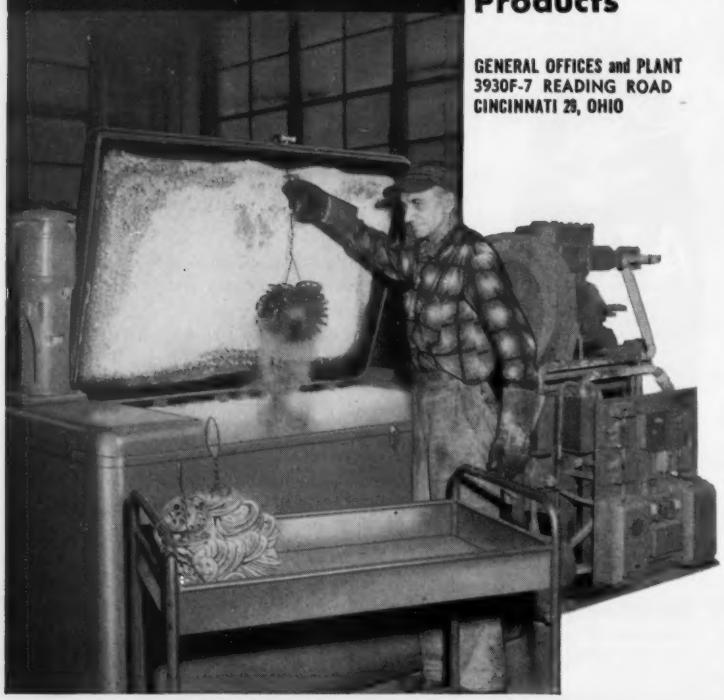
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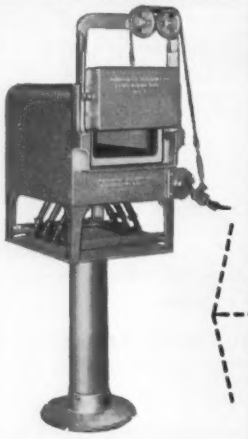
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